CONTRACT DOCUMENT

FOR THE

CONSTRUCTION OF A 300Mℓ RESERVOIR, BULK PIPELINES AND ASSOCIATED INFRASTRUCTURE NEAR MULDERSVLEI

VOLUME 1A: C3.7 SPECIFICATIONS 1

(NON-RETURNABLE DOCUMENT)

ISSUED BY:	COMPILED BY:	For official use.
CITY OF CAPE TOWN **WATER AND SANITATION** **DIRECTOR: BULK SERVICES** Water and Sanitation Head Office 8 Voortrekker Road (corner of Mike Pienaar Boulevard) BELLVILLE 7535	**ZUTARI (PTY) LTD** 1 Century City Drive Waterford Precinct CENTURY CITY 7441	**TENDER SERIAL No.:** **SIGNATURES OF CITY OFFICIALS AT TENDER OPENING** 1. 2. 3.

MAY 2025

NAME OF TENDERING ENTITY	
EMAIL ADDRESS OF TENDERING ENTITY	
FAX NUMBER OF TENDERING ENTITY	
NATURE OF TENDER OFFER (please indicate below)	
Main Offer (see clause C.2.12)	
Alternative Offer (see clause C.2.12)	

[redacted]

C3.7 Specifications

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The C3.7 Specifications are included in this tender as two separate volumes: Volume 1A and Volume 1B, each containing distinct sections of the specifications in accordance with the table above.

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C3.7 Specifications

3.7.1 STANDARDISED SPECIFICATIONS

The following relevant standardised specifications, as listed below, shall form the Standard Specifications and apply to this contract.

Where reference is made to SANS 1200 standard specifications in this contract, it shall mean the **South African Bureau of Standards Standardized Specification for Civil Engineering Construction SANS 1200**, complete with any corrections and amendments applicable at the time of tendering. Amendments to the standard specifications are bound in the contract documents in C3.7.2: Project Specifications referring to the standard specifications.

Although not bound in nor issued with this document, the following standardised specifications from SABS Standardised Specifications for Civil Engineering Construction SANS 1200 form part of the contract document and, notwithstanding Subclause 2.2 of SANS 1200 A, the editions specified below shall apply:

Section	Edition	Title
SANS 1200 A	1986	General
SANS 1200 AB	1986	Engineer's Office
SANS 1200 C	1980	Site Clearance
SANS 1200 D	1990	Earthworks
SANS 1200 DB	1989	Earthworks (Pipe Trenches)
SANS 1200 DE	1984	Small Earth Dams
SANS 1200 DK	1996	Gabions and Pitching
SANS 1200 DM	1981	Earthworks (Road, Subgrade)
SANS 1200 G	1982	Concrete
SANS 1200 GF	1984	Prestressed Concrete
SANS 1200 H	1990	Structural Steelwork
SANS 1200 HB	1985	Cladding and Sheeting
SANS 1200 HC	1988	Corrosion Protection of Structural Steelwork
SANS 1200 L	1983	Medium Pressure Pipelines
SANS 1200 LB	1983	Bedding (Pipes)
SANS 1200 LC	1981	Cable Ducts
SANS 1200 LD	1982	Sewers
SANS 1200 LE	1982	Stormwater Drainage
SANS 1200 LF	1983	Erf connections (water)
SANS 1200 LG	1983	Pipe Jacking
SANS 1200 M	1996	Roads (General)
SANS 1200 ME	1981	Subbase
SANS 1200 MF	1981	Base
SANS 1200 MH	1996	Asphalt base and surfacing
SANS 1200 MJ	1984	Segmented Paving
SANS 1200 MK	1983	Kerbing and Channelling
SANS 1200 MM	1984	Ancillary Roadworks

Any other SANS 1200 Standardized Specification to which reference is made in any of the above-listed Standardized Specifications shall apply but only to the extent required by such reference.



3.7.2 AMENDMENTS TO THE STANDARDISED SPECIFICATIONS

The following Amendments to SANS 1200 standard specifications are included in this C3.7.2: Amendment to the Standardised Specification (project specification referring to the Standard Specification).

Section	Title	Pages
SANS 1200 A	General	24
SANS 1200 AB	Engineer's Office	8
SANS 1200 C	Site Clearance	6
SANS 1200 D	Earthworks	23
SANS 1200 DB	Earthworks (Pipe Trenches)	14
SANS 1200 DE	Small Earth Dams	16
SANS 1200 DK	Gabions and Pitching	10
SANS 1200 DM	Earthworks (Road, Subgrade)	12
SANS 1200 G	Concrete	41
SANS 1200 GF	Precast Concrete (structural)	8
SANS 1200 H	Structural Steelwork	12
SANS 1200 HB	Cladding and Sheeting	5
SANS 1200 HC	Corrosion Protection of Structural Steelwork	5
SANS 1200 L	Medium Pressure Pipelines	16
SANS 1200 LB	Bedding (Pipes)	7
SANS 1200 LC	Cable Ducts	6
SANS 1200 LD	Sewers	10
SANS 1200 LE	Stormwater Drainage	7
SANS 1200 LG	Pipe Jacking	10
SANS 1200 M	Roads (General)	3
SANS 1200 ME	Subbase	7
SANS 1200 MF	Base	4
SANS 1200 MH	Asphalt base and surfacing	7
SANS 1200 MJ	Segmented Paving	4
SANS 1200 MK	Kerbing and Channelling	11
SANS 1200 MM	Ancillary Roadworks	5
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These amendments to the standardised specifications form an integral part of the contract documents and supplement the standard specifications.

In the event of any discrepancy between these amendments and a part of the standard specifications, the schedule of quantities, or the drawings, the these amendments shall take precedence.

In certain clauses the standard and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this part of the specifications. It also contains additional specifications required for this particular Contract.

The Amendments to the Standard Specifications are included as stand-alone sections, each with their own index pages. The paragraph and sub-paragraph numbers of each amendment are unique to the Standard Specification at hand. Each paragraph and sub-paragraph are immediately followed by the heading and the number of the clause or sub-clause in the Standard Specification being referenced.

New clauses and sub-clauses, which do not form part of a clause or sub-clause in the Standard Specifications are also included. The paragraph and sub-paragraph numbers of each of the new clauses and sub-clauses are also unique to the Standard Specification at hand. New clauses and sub-clauses are identified by the text "NEW" in their headings. Each paragraph and sub-paragraph which references a new clause or sub-clause is immediately followed by its heading containing the new clause or sub-clause number.

Replace the term "Engineer" wherever it may occur in any of the specifications with "Employer's Agent".

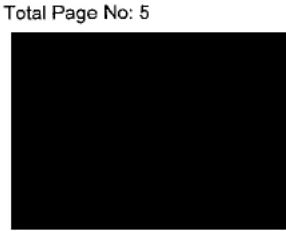
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1. SCOPE (CLAUSE 1)

Replace the contents of Subclause 1.1, including the notes, with the following:

"This specification covers requirements, principles and responsibilities of a general nature, which are generally applicable to civil engineering construction and building works contracts, as well as the requirements for the Contractor's establishment on the Site."

2. INTERPRETATIONS (CLAUSE 2)

2.1 APPLICABLE EDITION OF STANDARDS (SUBCLAUSE 2.2)

Add the following to the end of Subclause 2.1:

"These specifications shall be read in conjunction with any amendments to them. Any references to these specifications shall refer to these specifications as amended (if applicable)."

Add at the beginning of Subclause 2.2:

"Unless a specific edition is specified (see the List of Standardised Specifications), ..."

2.2 DEFINITIONS (SUBCLAUSE 2.3)

In the opening sentence between the words "specification" *and* "the following", *insert the words:* ", the definitions given in the General Conditions and".

Add the following definitions to Subclause 2.3(a):

"General Conditions and Conditions of Contract. The Conditions of Contract specified for use with this Contract, as detailed in the Contract Data.

Specified. As specified in the Conditions of Contract, Scope of Work (if applicable), Employer's Requirements (if applicable), Drawings, Schedule of Quantities and any other specification included in the Contract. 'Specification(s)' shall have the corresponding meaning.

Site. This term shall be as defined in the Conditions of Contract but may also consist of multiple places or Sites.

Bill of Quantities. This term shall be synonymous with 'Schedule of Quantities'.

Schedules of Rates and/or Prices. This term shall be synonymous with 'Schedule of Quantities'.

SABS. Except for references to the Bureau itself, or to the (official) SABS mark, the term 'SABS' shall mean 'SANS'.

Replace the *definitions for* 'Fixed charge' *and* 'Time-related charge' *under Subclause 2.3(c) with the following:*

Fixed charge. A charge that is not subject to adjustment on account of variations in the value of the Contract Price or the time allowed in the Contract for the completion of the work.

Time-related charge. A charge for a schedule item, the amount of which varies in accordance with the time for the completion of the item, adjusted in accordance with the provisions of the Contract.

Remove the definition for 'Value-related charge' from Subclause 2.3(c).

2.3 ABBREVIATIONS (SUBCLAUSE 2.4)

Add the following abbreviations to Subclause 2.4(a):

"CKS : SABS Co-ordinating Specification"

"TMH1 : Technical Methods for Highways 1"

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Add the following abbreviation under Subclause 2.4(b):

"MAMDD : Modified AASHTO maximum dry density."

"MDD : Maximum dry density."

2.4 ITEMS IN SCHEDULE OF QUANTITIES (SUBCLAUSE 2.8)

2.4.1 Principle (Subclause 2.8.1)

In the fourth line, after the words "standardized specification", add:

"or in the measurement and payment clause of the standard specification, particular specification and project specification and any amendments thereto,".

At the end of this Subclause add the following paragraphs:

"The Contractor shall be deemed to have inspected and examined the Site and its surroundings and information available in connection therewith, and to have satisfied himself before submitting his tender (as far as is practicable) as to:

(a) the form and nature of the Site and its surroundings, including subsurface conditions,

(b) the hydrological and climatic conditions,

(c) the extent and nature of work and materials necessary for the execution and completion of the Works,

(d) the means of access to the Site and the accommodation he may require,

(e) the location and nature of the site for the purpose of providing adequate security,

and, in general, shall be deemed to have obtained all information (as far as is practicable) as to risks, contingencies and all other circumstances which may influence or affect his tender.

The Contractor shall be deemed to have based his tender on the technical data given in the Documents and, if in the performance of the Contract any circumstances shall differ from the said technical data, which difference causes delay or additional cost, the Contractor shall be entitled to make a claim in accordance with Clause 10.1 [*Contractor's Claims*] of the General Conditions.

The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his tender for the Works, and of the rates and prices stated in the priced Schedules of Quantities, or in the specification, which rates and prices shall (except in so far as otherwise provided in the Contract) collectively cover full payment for the discharge of all his obligations under the Contract, and all matters and things necessary for the proper completion of the Works."

3. MATERIALS (CLAUSE 3)

3.1 QUALITY (SUBCLAUSE 3.1)

Add the following to the end of this Subclause:

"No used or recycled material may be used in the Works unless required in terms of the specification.

Where a material to be used in this Contract is specified to comply with the requirements of a SANS Standard Specification, and such material is available with the official SABS mark, the material used shall bear the official mark.

Samples of concrete aggregates are to be delivered to an approved laboratory.

Where proprietary products are specified, the Contractor may propose equal alternatives for approval by the Employer's Agent. Alternative materials or equipment proposed by the Contractor shall be tested. The test, as well as the materials or equipment, shall be approved by the Employer's Agent prior to any such materials or equipment being built into the Works, and all costs involved in testing shall be deemed to be included in the rates tendered."

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3.2 ORDERING OF MATERIALS (NEW SUBCLAUSE 3.3)

The quantities set out in the Schedules of Quantities have been carefully determined from calculations based on data available at the time of its compilation, but are to be considered as approximate quantities only. Before ordering materials of any kind the Contractor shall be solely responsible for determining, from the drawings issued or approved by the Employer's Agent for construction purposes, the actual quantities of materials required for the execution of the Works. No liability or responsibility whatsoever shall be attached to the Employer or the Employer's Agent in respect of materials ordered by the Contractor, except when ordered in accordance with the drawings issued or approved by the Employer's Agent for construction purpose.

4. PLANT (CLAUSE 4)

4.1 SILENCING OF PLANT (SUBCLAUSE 4.1)

Replace the contents of this Subclause with the following:

"The Contractor's attention is drawn to the applicable regulations pertaining to noise and hearing conservation, framed under the Occupational Health and Safety Act, 1993 (Act No 85 of 1993) as amended.

The Contractor shall at all times and at his own cost, be responsible for implementing all necessary steps to ensure full compliance with such regulations, including but not restricted to, the provision and use of suitable and effective silencing devices for pneumatic tools and other plant, which would otherwise cause a noise level in excess of that specified in the said regulations.

Where appropriate, the Contractor shall further, by means of temporary barriers, effectively isolate the source of such noise in order to comply with the said regulations."

4.2 CONTRACTOR'S OFFICES, STORES AND SERVICES (SUBCLAUSE 4.2)

Add the following before the first paragraph of this Subclause:

"4.2.1 General

The Contractor's buildings, sheds and other facilities erected or utilised on the Site for the purposes of the Contract shall be fenced off and his camp shall contain all offices, stores, workshops, testing laboratories, toilet facilities, etc. as may be required by the Contractor. The facilities shall always be kept in a neat and orderly condition.

Neither housing nor shelters are available for the Contractor's Employees, and the Contractor shall make his own arrangements to house his Employees off site and transport them to the Site. Only night-watchmen security may be on the Site after hours.

No water may be abstracted from water bodies for the purposes of construction without the approval of the Employer's Agent.

The Contractor's camp shall be kept neat and clean at all times and all surplus or rejected material shall be removed from the Site.

The Contractor shall provide facilities for the storage and handling of hazardous substances and liquid pollutants."

In the second paragraph, delete the words: "and first-aid services".

Add the following to the end of Subclause 4.2:

"4.2.2 Latrine facilities

The Contractor shall provide and maintain on the Site adequate and suitable sanitary services and a supply of potable water for his employees engaged on the Contract.

The Contractor shall provide on the Site and in close proximity to the actual locations where the work is being executed, one toilet per 10 workmen, which toilets shall be effectively screened from public view and their use

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enforced. Such toilets shall be relocated from time to time as the location of the work being executed changes, so as to ensure that easy access to the toilets is maintained

The suitable sanitary services shall be of the chemical type or better and shall be readily accessible to workers at all areas of the site.

The Contractor shall make all the necessary arrangements with the relevant local authority, or a commercial organisation approved by the local authority, for the disposal of the contents of the toilets on a regular basis

4.2.3 Medical facilities and safety equipment

The Contractor shall provide and maintain on the Site adequate first aid services. The first aid services shall include, inter alia, a First Aid cabinet fully equipped and maintained with at least the minimum contents as listed in the Annexure (Regulation 3) to the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), to deal with accidents and ailments which are likely to occur during the construction period.

The Contractor shall provide personal safety equipment and facilities as required by Regulation 2 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

5. CONSTRUCTION (CLAUSE 5)

5.1 SURVEY (SUBCLAUSE 5.1)

5.1.1 Setting out of the Works (Subclause 5.1.1)

Add the following to the end of this Subclause:

"Before commencing any construction, the Contractor shall check the relative positions and levels of all reference pegs, benchmarks and line pegs, and inform the Employer's Agent of any discrepancy.

The Contractor shall be responsible for the true and proper setting out of the Works and for the correctness of the position, levels, dimensions and alignment of all parts of the Works and for the provisions of all necessary instruments, appliances and labour in connection therewith.

A centreline survey, at 10 m intervals, shall be carried out by the Contractor as part of setting out of the Works. The survey data (X, Y, Z coordinates in a format acceptable to the Employer's Agent) shall be submitted to the Employer's Agent, who shall be afforded at least 14 days to verify the surveyed ground profile against the vertical pipeline alignments and to make changes to the construction drawings where required. Allowance shall be made in the construction programme for this verification process.

The Contractor shall carefully protect and preserve all benchmarks, sight-rails, pegs and other things used in setting out the Works. For any new work the Contractor shall establish his own reference points from which the work can be set out.

The checking of any setting-out or of any line or level by the Employer's Agent shall not relieve the Contractor of his responsibility for the correctness thereof.

If at any time during the progress of the Works, any error appears or arises in the position, levels, dimensions or alignment of any part of the Works, the Contractor, on being required to do so by the Employer's Agent, shall at his own expense rectify such error to the satisfaction of the Employer's Agent, but if such error is based on incorrect data supplied in writing by the Employer's Agent, or if there is any delay in providing the particulars required, which delays progress on the Contractor's critical path, the Contractor shall, in respect of that delay and the cost of such rectification, be entitled to make a claim in accordance with Clause 10.1 [*Contractor's Claims*] of the General Conditions."

5.1.2 Preservation and replacement of survey beacons and pegs subject to the Land Survey Act (Subclause 5.1.2)

In the second sentence of this Subclause, delete the words: "in the vicinity of boundaries". *In that same sentence, replace the words:* "under the direction of" *with:* "in consultation and liaison with".

Add the following to the end of the second sentence of this Subclause:

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[redacted]

"The Contractor and the Employer's Agent shall record on the said list, their concurrence or disagreement (as the case may be) regarding the completeness and accuracy of the details recorded therein."

Replace the third sentence of this Subclause with the following:

"At the completion of the Contract, the Contractor shall expose all pegs that were listed at the commencement of the construction as being in order and the Contractor shall arrange with a registered Land Surveyor for the checking of the positions of all such pegs and the replacement of those that the Land Surveyor's check reveals have become disturbed or damaged. The Contractor shall, as a precedent to the issuing of a Certificate of Practical Completion, provide to the Employer's Agent, a certificate from the registered Land Surveyor, certifying that all the pegs listed at the commencement of construction in accordance with the provisions of this clause, have been checked and that those found to have been disturbed, damaged or destroyed have been replaced in their correct positions, all in accordance with the provisions of the said Act.

The costs of all checking, replacement and certification as aforesaid shall be entirely for the Contractor's account. This, with the provision always that the Contractor shall not be held liable for the cost of replacement of pegs which:

(a) cannot reasonably be re-established in their original positions by reason of the finished dimensions of the permanent works, and

(b) the Contractor can prove beyond reasonable doubt to the satisfaction of the Employer's Agent, were disturbed, damaged or destroyed by others beyond his control."

5.1.3 As-built survey (New Subclause 5.1.3)

The Contractor shall supply the Employer's Agent with as-built survey data for the entire Works (including invert and cover levels, coordinates of manholes and points of intersection, valve chambers, etc). A Certificate of Practical Completion will not be issued until the as-built survey information had been approved by the Employer's Agent.

5.2 WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS (SUBCLAUSE 5.2)

Add the following at the end of this Subclause:

"The Contractor shall, in addition to the requirements of Subclause 5.1.6 of SANS 1200 D, carry out and maintain such Temporary Works, and provide all temporary road signs, as are necessary to maintain and safeguard the normal flow of public and private vehicular and pedestrian traffic.

All temporary signs shall be of the type and size required for rural roads, as applicable, as specified in the "Southern African Development Community Road Traffic Signs Manual and Chapter 13, [*Roadwork Signing*] of the South African Road Traffic Signs Manual"."

Without limiting the Employer's Agent's right to request additional requirements in terms of the Specifications and the General Conditions of Contract, the following shall be regarded as the minimum requirements for temporary fencing/barricading, lighting and traffic accommodation."

5.2.1 Temporary fencing/Barricading (New Subclause 5.2.1)

Excavations

The Contractor shall enclose all excavations with stout temporary orange barricade net fencing of at least 1.20m high fixed securely to supports as specified in the Health and Safety specification. The supports shall consist of poles or iron standards securely planted in solid ground at not more than 3m centres to enclose excavations. Where excavations are accessible to the general public, the excavations shall be enclosed with steel wire fencing of at least 1.5m high fixed securely to poles or iron standards securely planted in solid ground at not more than 3m centres.

In addition, the Contractor shall place concrete barriers where excavations are within the road reserve and when excavating alongside a trafficable road. Concrete barriers shall be connected with a 10mm thick connector plate and M24 bolts.

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5.2.2 Lighting (New Subclause 5.2.2)

Open trenches which constitute a hazard to pedestrians or traffic shall be illuminated by red lights in the following manner:

At least two red lights shall be placed across the ends of open trenches, at a maximum spacing of 2 metres.

Red lights shall be placed along open trenches at 10 m intervals on the road side and at 3 m intervals along the pedestrian side, where applicable.

At least 1 Red lamp shall be placed at each of the four corners of each pedestrian crossing and at least 2 red lamps at each of the four corners of each vehicular crossing.

All lamps shall be in position and burning between the hours of sunset and sunrise and shall be provided with a chain and padlock and locked to suitable posts of prevent theft.

5.2.3 Accommodation of traffic (New Subclause 5.2.3)

Accommodation of traffic and pedestrians will be required along alongside existing road and at road crossings.

Unless the closing of streets, accesses and thoroughfares has been properly arranged, the Contractor shall accommodate and provide for through traffic, traffic at crossings and vehicular access to houses and buildings at all times. If necessary, safe ramps to mount road kerbs shall be provided where traffic is to be diverted.

In the case of crossing of a main road, the Contractor shall so arrange his work that only half of the roadway is closed to traffic at any one stage during normal working hours. Outside of normal working hours both lanes of the roadway shall be open to traffic. Where both lanes cannot be opened outside of normal hours, the Contractor shall make provisions for temporary road markings to deviate traffic.

Should the Contractor wish to provide temporary bypasses for the deviation of traffic, these shall consist of a minimum of 100 mm of gravel wearing course on selected fill. The Contractor shall maintain the wearing course to the satisfaction of the Employer's Agent for the full time that the bypass is in use.

The Contractor shall submit drawings detailing the accommodation of traffic to the Employer's Agent for approval at least 14 days prior to construction. The deviation and signage shall be as specified in the "Southern African Development Community Road Traffic Signs Manual and Chapter 13, [*Roadwork Signing*] of the South African Road Traffic Signs Manual".

The Contractor's attention is drawn to the possibility of heavy volume and speed of traffic carried on the affected roads and shall make allowance therefore in his construction programme.

The Contractor shall liaise and cooperate with the relevant traffic authorities regarding the accommodation of traffic on existing roads. The Contractor shall indemnify the Local Authority, as applicable, from all liabilities in respect of excavations and works on or adjacent to trafficked roads.

The Contractor shall provide and maintain in a proper condition all necessary barricades, lights, warning signals and all direction signs necessary to accommodate the traffic during these stages. The Contractor shall also provide for flagmen at all deviations and/or obstructions where necessary. Open trenches shall be kept to a minimum and shall at all times be adequately demarcated, to protect pedestrians. The Contractor shall also ensure that access to properties affected by the works is maintained at all times.

~~The Contractor shall be responsible for the safe and easy accommodation of all traffic and the maintenance~~ of the vehicular and pedestrian access to private property for the deviation of the contract and at any time when work is undertaken during the maintenance period.

Flagmen shall be provided at all access and exit points to the working areas alongside public traffic. Flagmen equipped with high visibility safety jackets, red flags, STOP/GO-RY signs and two-way radios shall be stationed at each end of the road section to ensure an orderly flow of traffic past the work area. All signals must be clear, and the flagmen shall be intelligent and responsible personnel. In areas of high traffic density, the assistance of the relevant traffic authorities' officials shall be solicited.

All temporary barricades and delineators shall be mounted on portable supports to facilitate their moving. Only sandbags will be permitted for the ballasting of the supports. The sandbags shall consist of durable material and have adequate mass to prevent signs from being blown over by the wind. Sandbags shall be placed as ballast on the supports in front of and behind the sign so as not to obstruct the traffic path past the sign. The cost of the sandbags shall be included in the tendered rate for Accommodation of Traffic.

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At night and when directed by the Employer's Agent, red flashing warning lights shall be placed at strategic places such as barricades, obstructions, etc.

No traffic deviations or rerouting shall take place until all concrete barriers (if required) and signs are in place.

5.3 PROTECTION OF STRUCTURES (SUBCLAUSE 5.3)

Replace the words "Machinery and Occupational Safety Act, 1983 (Act No 6 of 1983)" *with* "Occupational Health and Safety Act, 1993 (Act No 85 of 1993), as amended,", *and after the words* "(Act No. 27 of 1956)", *insert the words* "as amended".

5.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES (SUBCLAUSE 5.4)

Replace this Subclause heading with "Location and Protection of Existing Services".

Replace the contents of this subclause with the following:

"5.4.1 Location of existing services

Before commencing with any work in an area, the Contractor shall ascertain the presence and actual position of all services shown on any plans, or which can reasonably be expected by an experienced and competent contractor to be present on, under, over or within the Site.

Without in any way limiting his liability in terms of the Conditions of Contract in relation to damage to property and interference with services, the Contractor shall, in collaboration with the Employer's Agent, obtain the most up-to-date plans as are available, showing the positions of services existing in the area where he intends to work. Neither the Employer nor the Employer's Agent offers any warranty as to the accuracy or completeness of such plans and because services can often not be reliably located from plans, the Contractor shall ascertain the actual location of services depicted on such plans by means of careful inspection of the Site.

Thereafter, the Contractor shall, by the use of appropriate methodologies, carefully expose the services at such positions as are agreed to by the Employer's Agent, for the purposes of verifying the exact location and position of the services. Where the exposure of existing services involves excavation to expose underground services, the further requirements of Subclauses 4.4 and 5.1.2.2 of SANS 1200 D shall apply.

The aforesaid procedure shall also be followed in respect of services not shown on the plans, but which may reasonably be anticipated by an experienced and competent Contractor to be present or potentially present on the Site.

All services, the positions of which have been determined as aforesaid at the critical points, shall henceforth be designated as 'known services' and their positions shall be indicated by the Contractor on a separate set of drawings, a copy of which shall be furnished to the Employer's Agent without delay.

As soon as any service which has not been identified and located as described above is encountered on, under, over or within the site, it shall henceforth be deemed to be a known service and the aforesaid provisions pertaining to locating, verifying and recording its position on the balance of the site shall apply. The Contractor shall notify the Employer's Agent immediately when any such service is encountered or discovered on the Site.

Whilst he is in possession of the Site, the Contractor shall be liable for all loss of or damage as may occur to

(a) known services, anywhere along the entire lengths of their routes, as may reasonably be deduced from the actual locations at which their positions were verified as aforesaid, due cognizance being taken of such deviations in line and level which may reasonably be anticipated, and

(b) any other service which ought reasonably to have been a known service in accordance with the provisions of this clause.

The Contractor shall also be liable for consequential damage in regard to (a) and (b), whether caused directly by the Contractor's operations or by the lack of proper protection.

No separate payment will be made to the Contractor in respect of his costs of providing, holding available on the Site and utilising the said detecting and testing equipment, nor for any costs incurred in preparing and submitting to the Employer's Agent the Drawings as aforesaid. These costs shall be deemed included in the Contractor's other tendered rates and prices included in the Contract.

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Payment to the Contractor in respect of exposing services at the positions agreed by the Employer's Agent and as described above, will be made under the payment items (if any) as may be provided for in the respective sections of the specifications pertaining to the type of work involved.

5.4.2 Protection during construction

The Contractor shall take all reasonable precautions and arrange his operations in such a manner as to prevent damage occurring to all known services during the period which the Contractor has occupation and/or possession of the Site.

Services left exposed shall be suitably protected from damage and in such a manner as will eliminate any danger arising therefrom to the public and/or workmen, all in accordance with the requirements of the prevailing legislation and related regulations.

Unless otherwise instructed by the Employer's Agent, no services shall be left exposed after its exact position has been determined and all excavations carried out for the purpose of exposing underground services shall be promptly backfilled and compacted. In roadways, the requirements of Subclause 5.9 of SANS 1200 DB should be observed. In other areas compaction is to be to 90% modified AASHTO density.

5.4.3 Alterations and repairs to existing services

Unless the contrary is clearly specified in the Contract or ordered by the Employer's Agent, the Contractor shall not carry out alterations to existing services. When any such alterations become necessary, the Contractor shall promptly inform the Employer's Agent, who will either make arrangements for such work to be executed by the owner of the service, or instruct the Contractor to make such arrangements himself.

Should damage occur to any existing services, the Contractor shall immediately inform the Employer's Agent, or when this is not possible, the relevant authority, and obtain instructions as to who should carry out repairs. In urgent cases, the Contractor shall take appropriate steps to minimise damage to and interruption of the service. No repairs of telecommunication cables or electric power lines and cables shall be attempted by the Contractor.

5.4.4 Existing fences, boundary walls and structures

Where work is carried out in the proximity of buildings, bridges, buried services, tanks, pipes, walls or other structures, the Contractor is reminded of his obligation to take all necessary precautions required in terms of the regulations framed under the Occupational Health and Safety Act (Act N° 85 of 1993) to ensure the safety of structures and services that are at risk.

Before commencing work in an area, the Contractor shall make sketches as directed by, and to the satisfaction of the Employer's Agent, and, if so directed, take photos of the fences, walls and structures within the working width, in order that the standard after completion of the Works can be compared with the original standard, and shall submit the sketches and photos to the Employer's Agent.

If the Employer's Agent issues a written instruction to remove existing fences, walls or other structures or parts thereof, the Contractor shall dismantle and recover the various components and store them in a security area. As soon as possible after completion of the work in the area, the Contractor shall, if so directed, re-erect the fences, walls or other structures to a standard at least equal to the original, using the recovered material as far as possible and, if necessary, new material of a type and quality equivalent to the original."

5.5 DEALING WITH WATER ON WORKS (SUBCLAUSE 5.5)

Replace the contents of this Subclause with the following:

"All water, whether from rain, pipeline failures, flooding, special water hazards or subsurface water and infiltration, etc., shall be dealt with in such a way as to ensure the safety of the Works.

It is required that adequate preventive, protection and control measures are taken and maintained by the Contractor for 24 hours per day, 7 days a week, throughout the period during which the facilities are required, to ensure that the Works are protected from damage due to water from any source and under any circumstance, whether abnormal or not.

The Contractor shall ensure that the water level outside all water retaining structures is at all times kept below the floor of the particular structure until the structure is filled with water, to prevent structural damage or floating.

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The Contractor shall design, construct, operate and maintain all drains and other Temporary Works necessary for the dewatering and flood protection of the permanent Works. All methods of dewatering and flood protection shall be submitted to the Employer's Agent for approval, which approval shall not relieve the Contractor of their obligations or responsibilities in regard to dealing with water.

In the event of these measures failing to protect the works, action shall be taken immediately by the Contractor to protect the Works from further damage, the cost of which shall be carried by the Contractor.

The Contractor shall be responsible for and shall repair at their own expense, any damage to the foundations, structures or any part of the Works caused by water that he is required to deal with, or failure of any part of the measures he has taken to protect the Works.

Once dewatering and protection measures have served their purpose, all Temporary Works shall be removed, and affected areas backfilled or levelled (as applicable) such that the operation of the Works not be affected in any way, and the Site restored to its original condition.

The cost of all flood protection and control of water measures shall be included in the tendered sum under item 8.3.2 and 8.4.2 of the Schedule of Quantities.

Where specialist dewatering measures are required for a project and is to be undertaken by a sub-contractor, the cost shall be included and paid for as a separate item under 8.3.7 and 8.4.7."

5.6 POLLUTION (SUBCLAUSE 5.6)

Add at the end of this Subclause:

"The Contractor shall comply with the Construction Environmental Management Plan included in the project specification."

5.7 SAFETY (SUBCLAUSE 5.7)

Replace the contents of this Subclause with the following:

"5.7.1 Occupational Health and Safety

The Contractor is to observe the provisions of the Occupational Health and Safety Act 85 of 1993, and the latest version of the related Construction Regulations (together hereinafter referred to as the Act), as well as the OHS requirements in the project specification.

Working on underground pipelines presents hazardous conditions and the Contractor's attention is drawn to the Act - General Safety Regulations and in particular the Regulation for working in confined spaces. The Contractor shall, in terms of the Act, address these hazards in his Health and Safety Plan.

All work and particularly work carried out in the proximity of buildings, bridges, tanks or other structures shall be carried out in conformance with the regulations framed under the Act, and the Minerals Act, Act 50 of 1991, including shoring where necessary, to ensure the safety of structures that are at risk.

The Contractor shall give notice to the Provincial Director, in terms of the Act, prior to the commencement of work on Site.

Pursuant to the provisions of the Conditions of Contract, and without in any way limiting the Contractor's obligations thereunder, the Contractor shall at his own expense (except only where specific provision (if any) is made in the Contract for the reimbursement to the Contractor in respect of particular items), provide the following:

(a) Provide to its Employees on the site of the Works, all safety materials, clothing and equipment necessary, to ensure full compliance with the provisions of the Act, at all times, and shall institute appropriate and effective measures to ensure the proper usage of such safety materials, clothing and equipment at all times;

(b) Provide, install and maintain all barricades, safety signage and other measures to ensure the safety of workmen and all persons in, on and around the site, as well as the general public;

(c) Implement on the site of the works, such procedures and systems and keep all records as may be required to ensure compliance with the requirements of the Act at all times;

(d) Implement all necessary measures so as to ensure compliance with the Act by all subcontractors engaged by the Contractor and their employees engaged on the works;

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(e) Full compliance with all other requirements pertaining to safety as may be specified in the Contract.

The Employer and the Employer's Agent shall be entitled, although not obliged, to make such inspections on the site as they shall deem appropriate, for the purpose of verifying the Contractor's compliance with the requirements of the Act. For this purpose, the Contractor shall grant full access to the site of all parts of the site and shall co-operate fully in such inspections and shall make available for inspection all such documents and records as the Employer's and/or Employer's Agent's representative may reasonably require.

Where any such investigations reveal, or where it comes to the Employer's Agent's attention that the Contractor is in any way in breach of the requirements of the Act or is failing to comply with the provisions of this clause, the Employer's Agent shall, in accordance with the provisions of Clause 5.11.2 of the General Conditions, be entitled to suspend progress of part or all of the Works until such time as the Contractor has demonstrated to the satisfaction of the Employer's Agent, that such breach has been rectified, which breach will be just cause for the suspension, and thus the responsibility of the Contractor as contemplated in this clause.

The Contractor shall have no grounds for a claim against the Employer for extension of time and/or additional costs if the progress on the Works or any part thereof is suspended by the Employer's Agent in terms of this clause, and the Contractor shall remain fully liable to complete the Works within the specified time for completion, irrespective of the suspension.

Persistent and repeated breach by the Contractor of the requirements of the Act and/or this clause shall constitute grounds for the Employer's Agent to act in terms of Clause 9.1 of the General Conditions, and if the Contractor fails to respond satisfactorily, for the Employer to Terminate the Contract in accordance with the provisions of Clause 9.2 of the General Conditions.

5.7.2 Construction hazards

Besides any other potentially hazardous conditions on Site, the possibility of high water pressures shall be taken into account when working with live water mains.

Some of the existing pipelines to be repaired and/or rehabilitated are of asbestos cement. Working with asbestos cement can present hazardous conditions and the latest Asbestos Regulation shall apply.

The safety of the public and all workers and the provision of all necessary safety equipment for the protection of workmen shall be the Contractor's sole responsibility."

5.8 GROUND AND ACCESS TO WORKS (SUBCLAUSE 5.8)

Add at the end of this Subclause:

"The Contractor shall, during construction of the Works:

a) improve and maintain to a standard that will ensure the safe execution of the Works, any existing access roads or roads built under this Contract, and tracks required by him for the Works.

b) construction and maintain additional roads as necessary for his purposes to and along the working width of the pipeline route, to a standard required for the efficient construction of the Works.

c) keep all roads and access tracks used by him watered to minimise dust. The frequency of the watering shall be at least daily when roads and tracks are used by the Contractor, unless it is sufficiently damp after rain.

d) not operate outside the "working width" or construction area as defined on the drawings, and he will be held wholly responsible for any damage or nuisance caused by himself, his plant, vehicles or staff throughout the period of the Contract.

Immediately on completion of each section of the Works, the Contractor shall:

i) reinstate all private roads used by him, other than those under (ii) below, to at least their original condition,

ii) scarify all roads constructed by him for construction purposes, and which are not required by the property owner or the Employer,

On completion of operations the Contractor shall restore the ground surface, wherever it may have been disturbed, to its original condition by filling in all ruts with material similar to the material within the rut and levelling the ground and, where necessary, planting grass and shrubs as may be required. Any boundary

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fences which have been removed or damaged by his operations and activities shall be repaired and/or reinstated at the Contractor's expense. Ground restoration must include proper placement of topsoil profile.

The relevant provisions of the Construction Environmental Management Plan, included in the project specification, shall also apply."

5.9 DRAWINGS AND DETAILS (NEW SUBCLAUSE 5.9)

Add the following to Subclause 5:

Tender drawings shall not be used for construction purposes. Construction drawings and additional detailed information will be made available to the Contractor as and when required by him.

The originals of all Drawings and Specifications prepared by or on behalf of the Employer's Agent shall remain in his custody and references herein to delivery to the Contractor of Drawings or Specifications shall relate to true electronic copies thereof.

The Contractor shall, to the extent provided in the Contract, receive electronic copies of each such Drawing and on his own accord and cost produce hard copies as he shall reasonably require.

One hard copy of all documents constituting the Contract shall be kept on the Site and be available for perusal by the Employer's Agent or any person authorised by him.

The Contractor shall, in accordance with the Employer's Agent's instructions, maintain a register on the Site of all Drawings and revisions thereof in the chronological order in which they are delivered to him.

5.10 PROVISION OF SECURITY MEASURES (NEW SUBCLAUSE 5.10)

Add the following to Subclause 5:

The Contractor shall ensure safety of and protect the Works from theft and vandalism. The Contractor shall be responsible for the safety and security of his personnel, materials on Site and the Works in general at all times. The Contractor shall therefore acquaint himself with the situation in the area with regard to safety and security (liaising with the local police as necessary) and shall provide all security measures deemed necessary to comply with the requirements under this clause in the Contract.

The Contractor shall make use of a professional service provider who is registered and compliant with the Private Security Industry Regulatory Authority (PSIRA). All security personnel provided by the service provider must also be registered with PSIRA. Upon appointment of the service provider the Contractor shall provide proof of the above-mentioned PSIRA registration. The Contractor shall ensure that the service provider has the necessary insurance in place to cover the service provider against any negligence on the part of the service provider.

5.11 ORTHOPHOTOGRAPHY AND AERIAL PHOTOGRAPHY (NEW SUBCLAUSE 5.11)

Digital ortho-photography and aerial photography shall be captured using an Unmanned Aerial Vehicle (UAV or Drone). The UAV shall be operated by a licenced operator and acquire all permits and licenses required for operating a UAV in the project area.

All photography produced shall be safely stored by the Contractor for the duration of the contract and the defect liability period. The copyright ownership for all photography shall be transferred to the Employer. The Contractor shall not share the information captured under this clause without the consent of the Employer.

5.11.1 Orthophotography (New Subclause 5.11.1)

Orthophotography shall be captured of areas of the works as scheduled. The digital ortho-photography shall have a ground sample distance (GSD) not greater than 0.1 m. Upon completion of the data capture phase, all ortho-photography imagery will undergo rigorous processing to ensure accuracy and quality. The ortho-photography images will be orthorectified using ground control points (GCPs) collected during the data capture phase. Digital terrain models (DTMs) or digital surface models (DSMs) will be utilized to correct for terrain distortions and ensure accurate geometric alignment. Ortho-photography images will be mosaicked and blended seamlessly to produce a coherent and consistent representation of the captured area. The ortho-photography for the entire area captured shall be provided in a coordinated TIF file to the Employer's Agent within one month of capture.

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5.11.2 Aerial Imagery (New Subclause 5.11.2)

Aerial photography shall also be taken of prominent structures or features on site as scheduled. The aerial photography shall be taken from a minimum of 8 oblique perspectives covering the entire perimeter of the structure. The aerial photography shall have a resolution of at least 15 megapixels and shall be provided in a JPG to the Employer's Agent within a week of being captured.

6. TOLERANCES (CLAUSE 6)

Add the following to Subclause 6:

6.1 USE OF TOLERANCES (NEW SUBCLAUSE 6.4)

No guarantee is given that the full specified tolerances will be available independently of each other, and the Contractor is cautioned that the liberal or full use of any one or more of the tolerances may deprive him of the full or any use of tolerances relating to other aspects of the work.

Except where the contrary is specified, or when clearly not applicable, all quantities for measurement and payment shall be determined from the 'authorised' dimensions. These are specified dimensions or those shown on the Drawings or, if changed, as finally prescribed by the Employer's Agent, without any allowance for the specified tolerances. Except if otherwise specified, all measurements for determining quantities for payment will be based on the 'authorised' dimensions.

If the work is constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the calculation of quantities will be based on the 'authorised' dimensions, regardless of the actual dimensions to which the work has been constructed.

When the work is not constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the Employer's Agent may nevertheless, at his sole discretion, accept the work for payment. In such cases no payment shall be made for quantities of work or material in excess of those calculated for the 'authorised' dimensions, and where the actual dimensions are less than the 'authorised' dimensions minus the tolerance allowed, quantities for payment shall be calculated based on the actual dimensions as constructed.

7. TESTING (CLAUSE 7)

7.1 PRINCIPLES (CLAUSE 7.1)

7.1.1 Checking (Subclause 7.1.1)

Add the following at the end of this Subclause:

"Every completed layer and section of the Works shall be subject to check testing by the Contractor, at his own cost. Once the Contractor has satisfied himself with the standard of his works, he shall provide the Employer's Agent with the results of his check testing indicating that the work is to specification. In order to minimize delays due to testing, the Contractor shall give the Employer's Agent at least 24 hours' notice of when any layer and portion of the Works will be completed to his satisfaction, so that the Employer's Agent can arrange for his acceptance control testing to be done.

Failure by the Contractor to notify the Employer's Agent or to provide the required information or, where specified, to perform the required test, will be grounds to exempt the Employer from payment for the associated work and for all subsequent work which would be affected by the failure of the work to be tested.

The Employer's Agent will be under no obligation to the Contractor to perform acceptance tests. If the Employer's Agent elects not to perform a particular test after notification by the Contractor, he will issue the Contractor with a written instruction to proceed with the relevant works without the acceptance test being performed.

Nothing contained in this Clause will relieve the Contractor of his responsibilities under the specification or in any way limit the tests which the Employer's Agent may call for or perform in terms of the specification."

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7.1.2 Standard of Finished Work not to Specification (Subclause 7.1.2)

Add the following at the end of this Subclause:

"In addition, the costs of check testing by the Employer's Agent, including tests carried out by commercial laboratories after remedial work by the Contractor, shall be borne by the Contractor."

7.2 APPROVED LABORATORIES (CLAUSE 7.2)

Replace the contents of Subclause 7.2 with the following:

"Unless otherwise specified in the relevant specification or elsewhere in the Project Specifications, the following shall be deemed to be approved laboratories in which design work, or testing required in terms of a specification for the purposes of acceptance by the Employer's Agent of the quality of materials used and/or workmanship achieved, may be carried out:

(a) Any testing laboratory certified by the South African National Accreditation Systems (SANAS) in respect of the nature and type of testing to be undertaken for the purposes of the Contract;

(b) Any testing laboratory owned, managed or operated by the Employer or the Employer's Agent;

(c) Any testing laboratory established and operated on the Site by or on behalf of the Employer or the Employer's Agent;

(d) Any other laboratory that the Employer's Agent approves in his absolute discretion;

(e) Concrete testing and technical analysis shall be carried out by the Structural Employer's Agenting/Concrete Laboratory at the University of Cape Town, or equal approved by the Employer's Agent.

If required, the Employer's Agent will employ the services of a commercial laboratory in order to carry out acceptance testing. All acceptance testing carried out by a commercial laboratory shall be paid for by the Contractor. The costs of such tests shall be deemed to be included in the relevant rates.

The Contractor shall make due allowance for testing procedures in his construction programme."

8. MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 MEASUREMENT (SUBCLAUSE 8.1)

8.1.1 Method of Measurement, All Sections of the Schedule (Subclause 8.1.1)

Delete the words "and South West Africa".

8.1.2 Preliminary and General Item or Section (Subclause 8.1.2)

8.1.2.1 Contents (Subclause 8.1.2.1)

Replace the last sentence of Subclause 8.1.2.1(b) with the following:

"Separate items will be scheduled to cover the fixed charge and time-related components of the Contractor's preliminary and general costs."

*For Subclause 8.1.2.1(c), replace the words "*the substantial completion certificate*" with the words "*Certificate of Practical Completion".

Add the following to the end of Subclause 8.1.2.1(c):

"Notwithstanding the above, should a Certificate of Practical Completion be issued with a list of outstanding work and defects, those preliminary and general items and responsibilities necessary to complete the outstanding work and remedy the defects, in the opinion of the Employer's Agent, shall not cease or be removed but shall remain and continue at the Contractor's own cost until the work is complete and defects remedied to the satisfaction of the Employer's Agent."

*Remove the phrases "*same section of the*" and "*prime cost items,*" from Subclause 8.1.2.1(d).*

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8.1.2.2 Tendered sums (Subclause 8.1.2.2)

Replace the *contents of this Subclause with the following:*

"Except only where specific provision is made in the Specifications and/or the Schedules of Quantities for separate compensation for any of these items, what is covered by the Contractor's tendered sums is specified in Subclauses 8.3 and 8.4 of this amendment, and shall collectively cover his direct costs plus overheads, and include his profit and all costs and expenses that he requires for the item(s) specified, as well as for all general risks, liabilities and obligations set forth or implied in the documents on which the tender is based, and further, all expenses of a general nature not specifically related to any item or items of the permanent or temporary work."

8.2 PAYMENT (SUBCLAUSE 8.2)

8.2.1 Fixed-charge and value-related items (Subclause 8.2.1)

*Remove the words "*and value-related*" from the heading and content of this Subclause.*

Add the following to the end of this Subclause:

"Should the Contractor fail to provide, within a reasonable amount of time as determined by the Employer's Agent, all the services and facilities or meet all the responsibilities, obligations and liabilities required of him in respect of any fixed-charge items, the Employer's Agent may suspend progress of part or all of the Works until such time as they are fully provided/met.

NOTE: An approved extension of time will not qualify the Contractor to receive any additional payment for fixed charge items, nor receive any payment for that portion of these items which have become regarded as 'time-related' items."

8.2.2 Time-Related Items (Subclause 8.2.2)

Replace the contents of this Subclause with the following:

"Payment for time-related items scheduled as lump sums or at monthly rates (if applicable), will be effected as follows, only after the relevant fixed-charge item has been provided/implemented, and certified for payment:

Subject to the provisions of Subclauses 8.2.3 and 8.2.4 of this amendment, for lump sum items, payment of monthly incremental amounts (calculated by the division of the remainder of the tendered sums by the realistic number of remaining months, as determined by the Employer's Agent, for the completion of the relevant items) will be authorized in each of the subsequent progress certificates until the sum tendered has been paid, subject to full compliance. Should any item be provided/implemented later than required, the tendered sum will be reduced pro rata to the extent of lateness.

For items scheduled at monthly rates, also subject to the provisions of Subclauses 8.2.3 and 8.2.4 of this amendment, payment at the monthly rate will be authorized in each of the subsequent progress certificates, until realistic completion of the relevant item or need for it, all as determined by the Employer's Agent, or the due completion thereof, whichever is the shorter time, also subject to full compliance.

NOTE: Unless an extension of time is approved without costs, an approved extension of time may qualify the Contractor to receive payment for each relevant time-related item at a unit rate determined from the sum tendered for such item and the period for the completion of the item."

8.2.3 Withholding of Payment for Time-related Items (Subclause 8.2.4)

*Replace this Subclause heading with "*Omitting Payment for Time-related Items".

Replace the contents of this Subclause (8.2.4.1 through 8.2.4.3 inclusive) with the following:

"Should the Contractor fail to provide all or part of the services and facilities or meet all or part of the responsibilities, obligations and liabilities required of him in a particular period in respect of any time-related item, all or part of the relevant incremental amount for that item will be omitted and the total amount of the contract reduced accordingly. Should the Contractor not remedy the failure within a reasonable amount of time as determined by the Employer's Agent, the Employer's Agent may suspend progress of part or all of the Works until the failure has been resolved.

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Notwithstanding how payment for time-related items are calculated in Subclause 8.2.2 above, the incremental amount omitted for each relevant time-related item shall be at a unit rate determined from the sum tendered for such item and the period for the completion of the item."

8.3 SCHEDULED FIXED-CHARGE AND VALUE-RELATED ITEMS (SUBCLAUSE 8.3)

Remove the words "and value-related" *from the heading of this subclause.*

Delete Subclauses 8.3.2, 8.3.3 and 8.3.4, and substitute with the following:

"8.3.2 Establishment of Facilities on the Site

8.3.2.1 Facilities for Employer's Agent ..... Unit: Sum

The sum shall cover all costs for providing, establishing and commissioning on the Site all facilities specified for the Employer's Agent, adequately equipped to allow the work to commence and to proceed to completion as required in terms of the Contract. This includes for, but is not limited to, meeting all the requirements specified in SANS 1200 AB, excluding the time-related costs scheduled separately under Subclause 8.4.2.1.

8.3.2.2 Facilities for Contractor ..... Unit: Sum

Facilities for the Contractor will not be measured and paid for separately, but all consolidated into two items, one item covering all fixed-charge requirements (this scheduled item) and the other covering all time-related requirements (scheduled under Subclause 8.4.2.2).

The sum for this item shall cover the cost of providing, establishing and commissioning on the Site all facilities for the Contractor which are adequately equipped to allow the work to commence and to proceed to completion as required in terms of the Contract.

These facilities for the Contractor include offices, storage sheds, workshops, laboratories, living accommodation, ablution, latrine and medical facilities, tools and equipment (including safety equipment), water supplies, electric power and communications, generators (load shedding), sewage, rubbish disposal, dealing with water on the Works (see Subclause 5.5) except for areas scheduled separately under Subclause 8.3.7, access (see Subclause 5.8), plant (designated plant or plant for designated operations or plant for use during stated periods; applicable only to specifically identified plant), fencing off the Contractor's camp (see Subclause 4.2) and all other facilities the Contractor may require.

8.3.3 Environmental Management ..... Unit: Sum

The sum tendered shall cover all costs of whatsoever nature, excluding the time-related costs scheduled separately under Subclause 8.4, of complying with all specified environmental management (and related) requirements.

8.3.4 Health and Safety ..... Unit: Sum

The sum tendered shall cover all costs of whatsoever nature, excluding the time-related costs scheduled separately under Subclause 8.4 or costs already included for in facilities for Employer's Agent and Contractor, of complying with all specified health and safety (and related) requirements.

8.3.5 Provision of Security Measures ..... Unit: Sum

The sum tendered shall cover all costs of whatsoever nature, excluding the time-related costs scheduled separately under Subclause 8.4, of complying with the requirements of Subclause 5.10.

8.3.6 Accommodating Other Contractors ..... Unit: Sum

The sum tendered shall cover all costs of whatsoever nature, excluding the time-related costs scheduled separately under Subclause 8.4, associated with accommodating other contractors on or adjacent the Site, as outlined in the project specification.

8.3.7 Dealing with water in areas scheduled ..... Unit: Sum

Dealing with water on the Works shall be included for in the sum tendered for facilities for the Contractor (see Subclause 8.3.2.2) except for areas scheduled separately under this subclause.

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The sum tendered for areas scheduled separately shall cover all costs, excluding the time-related costs scheduled separately under Subclause 8.4, for dealing with water (see Subclause 5.5) in the scheduled areas.

8.3.8 Quality Management ..... Unit: Sum

The sum tendered shall cover all costs of whatsoever nature, excluding the time-related costs scheduled separately under Subclause 8.4 or costs already included for in other rates, of complying with all quality management and quality assurance related requirements specified.

8.3.9 Removal of site establishment ..... Unit: Sum

The sum shall cover the cost of any demolition as may be necessary, and the complete removal from the surface of the Site, all scheduled fixed-charge items, and shall provide for the making good and the restoring of the Site to at least as good a condition as it was handed over, all to the satisfaction of the Employer's Agent.

In addition, the sum shall cover the cost of the work specified in Subclause 5.8 and the cost of complying with Subclause 5.15 of the General Conditions.

8.3.10 Other fixed-charge obligations ..... Unit: Sum

The sum shall cover the fixed costs of all other obligations that are required for the proper execution of the Works in accordance with the requirements of the specification and the Conditions of Contract, and that are not specifically covered elsewhere in Subclause 8.3."

8.4 SCHEDULED TIME-RELATED ITEMS (SUBCLAUSE 8.4)

Delete Subclauses 8.4.2, 8.4.3, 8.4.4 and 8.4.5, and substitute with the following:

"8.4.2 Operation and Maintenance of Facilities on Site, for Duration of Construction, except where otherwise stated

8.4.2.1 Facilities for Employer's Agent ..... Unit: Sum

The sum shall cover all costs in connection with facilities for the Employer's Agent for the periods stated for site rentals, repairs to and depreciation of buildings, furniture, tools and equipment, the storage and distribution of fuels and lubricants, water, electricity, water and electricity during load shedding, sewage, rubbish disposal, internet, communications, time lapse cameras, plant consumables, access, sanitation, and the wages of staff operating and maintaining these facilities in accordance with the contract. This includes for, but is not limited to, meeting all the requirements specified in SANS 1200 AB, excluding fixed-charge requirements scheduled separately under Subclause 8.3.2.1.

8.4.2.2 Facilities for Contractor ..... Unit: Sum

Facilities for the Contractor will not be measured and paid for separately, but all consolidated into two items, one item covering all fixed-charge requirements (scheduled under Subclause 8.3.2.2) and the other covering all time-related requirements (this scheduled item).

The sum for this item shall cover the Contractor's costs for the periods stated for site rentals, repairs to and depreciation of buildings, furniture, tools and equipment, the storage and distribution of fuels and lubricants, water, electricity, water and electricity during load shedding, sewage, rubbish disposal, internet, communications, plant consumables, access, sanitation, and the wages of staff operating and maintaining these facilities in accordance with the contract.

These facilities for the Contractor include, but are not limited to, offices, storage sheds, workshops, laboratories, living accommodation, ablution, latrine and medical facilities, tools and equipment (including safety equipment, water supplies, electric power and communications, generators, sewage, rubbish disposal, dealing with water on the Works (see Subclause 5.5) except for areas scheduled separately under Subclause 8.4.7, access (see Subclause 5.8), plant (designated plant or plant for designated operations or plant for use during stated periods; applicable only to specifically identified plant), fencing off the Contractor's camp (see Subclause 4.2) and all other facilities the Contractor may require.

8.4.3 Environmental Management ..... Unit: Sum

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The sum tendered shall cover all time-related costs of whatsoever nature of complying with all specified environmental management (and related) requirements.

8.4.4 Health and Safety ..... Unit: Sum

The sum tendered shall cover all time-related costs of whatsoever nature, excluding costs already included for in facilities for Employer's Agent and Contractor of complying with all specified health and safety and related requirements.

8.4.5 Provision of Security Measures ..... Unit: Sum

The sum tendered shall cover all time-related costs for complying with the requirements of 5.10.

8.4.6 Accommodating Other Contractors ..... Unit: Sum

The sum tendered shall cover all time-related costs associated with accommodating other contractors on or adjacent the Site, as outlined in the project specification.

8.4.7 Dealing with water in areas scheduled ..... Unit: Sum

Dealing with water on the Works shall be included for in the sum tendered for facilities for the Contractor (see Subclause 8.4.2.2) except for areas scheduled separately under this subclause.

The sum tendered for areas scheduled separately shall cover all time-related costs for dealing with water (see Subclause 5.5) in the scheduled areas.

8.4.8 Quality Management ..... Unit: Sum

The sum tendered shall cover all time-related costs of whatsoever nature, excluding costs already included for in other rates, of complying with all quality management and quality assurance related requirements specified.

8.4.9 Supervision for Duration of Construction ..... Unit: Sum

The sum shall cover the costs of on-site supervision and such local administration as the Contractor considers necessary for the proper completion of the Works, and shall cover the cost of the salaries, wages and allowances paid to the site agent, salaried general and/or section foremen (where applicable), site surveyors, timekeepers, assistants and other site supervisory staff, and of transport incurred in connection with such staff.

8.4.10 Company and Head Office Overhead Costs for the Duration of the Contract ..... Unit: Sum

The sum shall cover the Contractor's company and head office overhead costs.

8.4.11 Other Time-related Obligations ..... Unit: Sum

The sum shall cover the time-related costs of all other obligations that are required for the proper execution of the Works in accordance with the requirements of the specification and the Conditions of Contract, and that are not specifically covered elsewhere in Subclause 8.4."

8.5 SUMS STATED PROVISIONALLY BY EMPLOYER'S AGENT (SUBCLAUSE 8.5)

Replace the word "Engineer" with "Employer's Agent" from the heading of this subclause.

Delete the contents of Subclause 8.5, and substitute with the following:

"a) For work to be executed (including plant, materials or services to be supplied) by the Contractor, and valued in terms of the variation procedure in the Conditions of Conditions.

1. Description of work, etc. ..... Unit: Prov Sum

b) For work to be executed by a subcontractor, and/or for goods, materials, plant and/or services to be supplied to the Site.

1. Description of work, etc. ..... Unit: Prov Sum

2. Overheads, charges and profit on item (b)(1) above ..... Unit: %

3. Specified Contractor's activities (if any) associated with the two items (b)(1) and (b)(2) above, which are not already included for in other rates.

i) Description of work, etc. ..... Unit: Prov Sum or Sum or % on item (b)(1)

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Provisional Sums are allowances made by the Employer's Agent for items and/or operations that are not fully defined at the time of Tender but are to be included in the Contract and accounted for in the Contractor's programme. Provisional Sums shall only be used in accordance with the Employer's Agent's instructions.

The Employer's Agent will state in the schedule the provisional sum amount he requires in order to complete that which is stated in (a), (b)(1) and, if applicable, (b)(3), and specified more fully, if practicable, in the project specification and on the drawings.

Where provisional sums are scheduled, they shall be dealt with in terms of (a) where not followed in the schedule by a percentage for (b)(2), or dealt with in terms of (b)(1) where followed in the schedule by a percentage for (b)(2). Any percentage rate stated in the Appendix to Tender or fixed percent stated in the Conditions of Contract (as applicable) shall not be applicable to provisional sums dealt with in terms of (a), as they are to be valued in terms of the variation procedure.

The sum paid to the Contractor in (b)(1) shall be the actual amounts paid (or due to be paid) by the Contractor, exclusive of VAT.

The rate for (b)(2) shall cover the Contractor's profit, head office and Site overhead costs, correspondence, preparing quotes, liaising with suppliers and subcontractors, taking responsibility for subcontractors and ensuring subcontractor compliance with the Contract, supplying invoices, vouchers, delivery notes, receipts, taking delivery on Site, offloading and getting in, unpacking, storing and checking against invoices and delivery notes (as applicable), checking the quantity and condition of all materials and goods on taking delivery, and alerting the Employer's Agent and supplier upon taking delivery, of any issues. Any materials and goods subsequently found missing or damaged shall be replaced at the Contractor's expense. Where not already included for in other rates and prices, the rate for (b)(2) shall also cover costs and expenses for all general risks, liabilities and obligations set forth or implied in the documents on which the tender is based.

Any amount paid to the Contractor in (b)(2) shall be a percentage of the actual proven amount of the provisional sum used in (b)(1). As such, where the Employer's Agent decides not to proceed with or use a scheduled provisional sum in terms of (b)(1), no amount will be paid to the Contractor for work done in terms of (b)(2). As such, the Contractor performs work required in terms of (b)(2) at his own risk, without the guarantee that the provisional sum will actually be used, and no claims related to provisional sums not being used shall be entertained.

The rate for (b)(3) shall cover all costs associated with the work described against item (b)(3) in the schedule, and shall only be used for work to be executed by the Contractor not covered by (b)(1) and (b)(2). Where the unit of measure for (b)(3) is a percentage, it shall be a percentage of the actual amount of the provisional sum used in (b)(1). As such and as described for (b)(2), no amount will be paid to the Contractor for work done in terms of (b)(3) where a provisional sum is not used.

Where the unit of measure for (b)(3) is a provisional sum, it shall be evaluated in terms of (a)(1). Where the unit of measure for (b)(3) is a sum, it shall be paid in full if all work described against item (b)(3) is complete or, if not fully complete, the Employer's Agent shall evaluate what portion of the work has been completed and only that portion shall be due to the Contractor.

8.6 PRIME COST ITEMS (SUBCLAUSE 8.6)

Delete the heading and contents of this Subclause (as prime cost items are covered by 8.5.b) and replace with the following:

"8.6 PROVISIONAL ITEMS

The Employer's Agent may schedule provisional items to cover instances, work or activities (as applicable) that are provisional but are to be included in the Contract. Provisional work and activities shall only be carried out if instructed by the Employer's Agent. Where the unit of measure is 'days', it shall be calendar days excluding special non-working days.

a) All costs related to the provisional delay due to the late granting to the Contractor of access to and possession of the Site (Provisional) ..... Unit : Days

The rate tendered shall cover all costs contemplated in terms of the "Right of access to the Site" or "Access to the Site" Clause (as applicable) of the Conditions of Contract, and shall further include all applicable preliminary and general costs in terms of 8.1.2.

b) All costs related to the instances, work or activities described (provisional)..... Unit : As scheduled

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The rate tendered shall cover all costs of whatsoever nature, including but not limited to all applicable preliminary and general costs in terms of 8.1.2, related to that which is described in the schedule."

8.7 DAYWORK (SUBCLAUSE 8.7)

Deleted the contents of this Subclause and substitute with the following:

"Provisional items for Daywork are scheduled as follows:

a) Labour at hourly or daily rates for foremen, skilled, semi-skilled and unskilled labourers, electrical foremen, cable joiners, and other labour, all as scheduled.

b) Material as a Provisional Sum with a percentage allowance on the net cost.

c) The Contractor's own plant, at hourly or daily rates as scheduled.

d) Hired plant as a Provisional Sum with a percentage allowance on the net cost.

The unit rates for labour and Contractor's own plant, and the percentage allowances for addition to the net cost of materials and hired plant, shall cover overhead charges and profit, site supervision and site staff, insurances, use and maintenance of tools and equipment, holidays with pay, travelling allowances and travelling costs (transport of men by Contractor's transport or transport hired or paid for by the Contractor), lodging allowances and any other emoluments and allowances payable to the workmen, as well as cover meeting the requirements of Clause 6.5 of the General Conditions. The rates for the Contractor's own plant used for Daywork shall further cover the full and final cost of the use of such plant, including plant operators, consumable stores, fuel and maintenance, servicing, etc.

Only the net working hours will be measured under Daywork, and it will be held that the Contractor has made provision in his rates for possible interruptions and standing time. Hired plant for dayworks shall be used exclusively for dayworks and shall be hired for as short a period as practical. Hiring plant for longer than practical or necessary will not be accepted."

8.8 TEMPORARY WORKS (SUBCLAUSE 8.8)

8.8.1 Main Access Road to Works (Subclause 8.8.1)

Add the following to the end of this Subclause:

"The Contractor will be held to have satisfied himself with regard to the accessibility of the site and the standard of access available via the existing main roads, minor roads and tracks. The tendered sum shall cover the cost of the upgrading or constructing where necessary, existing access, including new access roads as required by the Contractor.

The tendered sum shall further include for the cost of maintenance to the standard specified throughout the construction period, watering as specified in Subclause 5.6 above, temporary repair of all existing access roads, new access roads required by the Contractor, and tracks, all required traffic accommodation and temporary signage and the reinstatement/scarifying of the roads as specified in Subclause 5.8 above."

8.8.2 Dealing with traffic (Subclause 8.8.2)

Add the following to this Subclause:

"The tendered sum for dealing with traffic shall include for the maintenance of access, protection at level crossings, and other requirements of Subclause 5.2 above.

The tendered rate shall include full compensation for accommodating traffic during the different specific construction operation(s) or work phases included in the contract. The tendered rate shall also include full compensation for the provision of communications equipment required for regulating the traffic, arranging for the moving of services and facilities, solving traffic problems, complying with the legal requirements of all authorities concerned, for providing temporary access to private property, and for the provision and maintenance of temporary drainage. Refer to Subclause 5.2.2 and Subclause 5.2.3 above.

The tendered rates sum shall include full compensation for the relocation of traffic-control facilities including dismantling, storing if necessary, transporting, re-erecting and inspecting the traffic-control facilities, and for all labour, equipment, constructional plant and incidentals as specified or shown on the drawings.

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The rate shall include for the sign stands, for the provision of two sand bags per sign to hold it in position and for their replacement when necessary. The rate shall also include the Contractor submitting traffic management plans for each type of crossing for the relevant authorities' approval.

No extra-payment will be made for temporary fencing/barricading and lighting required in the Occupational Health and Safety Specification included under C3.5.6.

The rates for placing of concrete barriers of excavations where excavations are within the road as specified in Subclause 5.2.3 shall be paid under Subclause 8.8.9."

8.8.3 Protection of.....structure until construction in vicinity is completed (Subclause 8.8.3)

Add the following to this Subclause:

" (a) Name/type of existing structure stated.....Unit : Sum/No

(b) Etc. for other structures.....Unit : Sum/No

The tendered sum(s) shall include full compensation for all the costs for protecting the existing structures until the construction in the vicinity is completed. Payment will be made in two equal instalments, the first when the protection measures are in place, and the second when the protection measures have been removed."

8.8.4 Cost of Survey in Terms of the Land Survey Act (Subclause 8.8.5)

Replace the contents of this Subclause with the following:

"The cost of the Contractor's responsibility for the setting out of the Works in terms of Subclause 5.1.1 and the preservation and replacement of beacons and pegs subject to the Land Survey Act in terms of Subclause 5.1.2 will be held to be covered by the sums tendered for Other Fixed-charge Obligations under Subclause 8.3 and Other Time-related Obligations under Subclause 8.4. Any costs incurred by the Employer or his representative in connection with the replacement of beacons or pegs for which the Contractor is responsible in terms of Subclause 5.1.2 will be recoverable from the Contractor by deduction from the monthly Interim Payment Certificate."

8.8.5 Special Water Control in Terms of Project Specification (Subclause 8.8.6).....Unit: Sum

Delete the heading and contents of this subclause.

All water shall be dealt with as per Subclause 5.5 and included for, unless otherwise indicated, in the rates applicable to Subclauses 8.3.7 and 8.4.7 of this amendment..

8.8.6 Survey (New Subclause 8.8.7).....Unit: Sum

Setting out

The cost of setting out, including the cost of establishing temporary bench marks and pegs in terms of Subclause 5.1.1, will be held to be covered by the rates tendered for the fixed charge and time related items in the Schedule of Quantities. No separate item will be scheduled for setting out of the works.

As-built survey

The sum(s) tendered for the relevant item(s) in Schedules of Quantities shall cover all costs associated with providing the Employer's Agent with the required as-built information of the Works in terms of Subclause 5.1.3.

8.8.7 Wayleaves (New Subclause 8.8.8).....Unit: Sum

The tendered sum(s) shall include full compensation to the Contractor for all the costs involved in obtaining all the necessary wayleaves as specified in the project specification.

8.8.8 Provision and installation of moveable concrete barriers (New Subclause 8.8.9)

Separate payment for the following will be made:

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(a) Provision and first installation. .....Unit : m

(b) Dismantling and re-erecting. .....Unit : m

(c) Final removal. .....Unit : m

The unit of measurement for subitem (a) shall be the length of movable concrete barrier in metres provided and installed including full compensation for the provision on site, offloading, positioning, placing, connecting barriers, etc.

The unit of measurement for subitem (b) shall be the length of movable concrete barriers in metres re-erected to new locations on site including full compensation for disconnecting, loading, transporting, offloading, positioning, placing, connecting barriers, etc.

The unit of measurement for subitem (c) shall be the length of movable concrete barriers in metres removed from site including full compensation for disconnecting, loading, transporting, offloading, etc.

8.8.9 Location and protection of existing services (New Subclause 8.8.10)

Where particular items are provided in other sections of the bills the costs of detection, exposure, protection and alterations shall be covered by such particular items. Where no such particular items are provided and where there is reason to expect the presence of such a service or services, the following items will apply:

8.8.9.1 Provision of non-destructive underground detecting for (New Subclause 8.8.10.1):

(a) Water and sewer pipes ..... Unit : Day

(b) Electrical and other cables ..... Unit : Day

(c) Telecommunication and signal cables. ..... Unit : Day

(d) Other (state)..... Unit : Day

(e) Hand excavation necessary for locating and exposing services:

(i) In roadways ..... Unit: m^3

(ii) In all other areas ..... Unit: m^3

(f) Process fieldworks (DTM model). .....Unit : No

The tendered rates for (a) to (d) above shall cover the cost of providing and operating suitable non-destructive underground detection equipment for as long as is necessary in order to locate all existing services likely to be affected by the construction activities. The equipment shall be able to detect service up a minimum depth of 3m. The unit of measure is day and payment will be made for each day that the field work takes place. If a single piece of equipment detects multiple service types, the quantity claimed for each type of service detected shall be calculated by dividing the total duration of fieldwork by the number of different service types detected.

The tendered rates for (e) above shall comply with the requirement of Subclause 8.3.8.1 of SANS 1200 D.

The tendered rate for (f) above shall also include the survey file of the detected services presented as a .DWG file compatible with AutoCAD containing 3D polylines of each service detected coordinated in plan and elevation. to the coordinate system stated on the drawings. The survey file will be supplied within within 3 days after completing the fieldwork. The unit of measure shall be number, and payment will be made for each instance and location at which underground service detection is done.

8.9 ASBESTOS SPECIALIST SERVICES (NEW CLAUSE 8.9):

(a) Appointment of an Approved Asbestos Inspection Authority (AIA) for the approval and monitoring of the asbestos plan of work, in accordance with the regulations .....Unit : Stated Sum

(b) Overheads, charges and profit on (a) above ..... Unit : %

(c) Handling of asbestos-containing waste on site in accordance with legislation ..... Unit : Sum

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(d) Transport and disposal of asbestos-containing pipes up to DN300 to a licensed hazardous waste disposal facility in accordance with legislation. ..... Unit : m

The tendered rate for sub item (c) shall cover all costs incurred by the contractor to comply with all the statutory requirements for working with asbestos containing waste in accordance with the relevant regulations and the project specific health and safety specification. Payment for this item shall include all the statutory requirements and recordkeeping as stated in Section 9 and 16 of the Asbestos Regulation.

The tendered rate for sub item (d) shall cover all costs for the transport and disposal of asbestos-containing pipes up to DN300 to a licensed and approved hazardous waste disposal facility, in accordance with the regulations, inclusive of all disposal charges from the permitted landfill site.

8.10 ORTHOPHOTOGRAPHY AND AERIAL PHOTOGRAPHY (NEW CLAUSE 8.10):

(a) Orthophotography..... Unit : No

The unit of measure shall be per number for each instance in which orthophotography is taken. Separate items shall be scheduled for each distinct area or site to be captured. The tendered rate shall cover the costs of all labour, material, equipment to capture, process and deliver the orthophotography as specified in subclause 5.11.

(b) Aerial photography..... Unit : No

The unit of measure shall be per number for each instance in which aerial photography is taken. Items shall be scheduled for each structure that must be captured. The tendered rate shall cover the costs of all labour, material, equipment to capture, process and deliver the aerial photography as specified in subclause 5.11.

8.11 MISCELLANEOUS ITEMS (NEW CLAUSE 8.11):

An item which, in the payment clause column of the Bill of Quantities, refers to this clause, will be measured in the unit scheduled. The sum or rate for such item shall cover the cost of all materials, labour and plant required to execute and complete the work as specified, described in the Bill of Quantities or shown on the drawing(s).

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1. SCOPE (CLAUSE 1)

Add the following paragraph at the end of this Subclause:

This specification covers the minimum required facilities that the Contractor is to provide for use on Site by the Employer's Agent and his guests. These required facilities include, but are not limited to, nameboards, office buildings, furniture, parking, protective clothing, regulation of electrical supply, plant, plant consumables, assistants, site instruction books and various services (such as water, electricity, sewage and rubbish disposal).

2. INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (SUBCLAUSE 2.3)

Delete the first two lines and substitute the following:

"For the purposes of this specification the definitions given in SANS 1200 A and the following definitions, shall apply."

2.2 FACILITIES (NEW SUBCLAUSE 2.4)

2.2.1 Facilities for the Employer's Agent (New Subclause 2.4.1)

Facilities for the Employer's Agent shall meet all requirements outlined in this specification (SANS 1200 AB), and shall include, without being limited to, nameboards, office buildings, furniture, parking, protective clothing, regulation of electrical supply, assistants, site instruction books and various services (such as water, electricity, sewage and rubbish disposal).

3. MATERIALS (CLAUSE 3)

3.1 NAMEBOARDS (SUBCLAUSE 3.1)

Replace the first sentence of this Subclause with the following:

"The Contractor shall supply and erect at approved sites, before commencing with construction of the Works, two nameboards. The nameboards shall comply as regards size, painting, decorating and detail, with the recommendations for the standard board of the Employer, or where no such standard board details exist for the Employer, that of Consulting Engineers South Africa."

Add the following at the end of this Subclause:

"The nameboards shall conform to the standard layout and design as formulated by the Employer (details available from the Employer's Agent). The wording for the name board shall be as ordered at the Commencement of Works. Before ordering or manufacturing the required nameboards, the Contractor shall obtain the Employer's Agent's written approval in respect of all names and wording to appear on the nameboards."

3.2 OFFICE BUILDING(S) (SUBCLAUSE 3.2)

Replace the contents of this Subclause with the following:

"The Contractor shall provide and have ready when commencing with work on Site, and thereafter maintain and service for the duration of construction, the following:

Six (6) "Kwikspace" or similar approved modular offices with a floor area of at least 14 m^2 per office. Each office shall, individually, include/contain:

a. one trestle table, 2 m long x 1 m wide x 0,9 m high, with a smooth top;

b. one high stool;

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c. two tables or desks having a top of size at least 1,5 m x 0,7 m of suitable height (0.7 m to 0.8 m), with at least one lockable drawer;
d. four sturdy office chairs;
e. "Barhold" or similar wall mounted rack with 6 clamps suitable for hanging A0 sized drawings;
f. either a lockable upright steel cabinet with three shelves or a steel filing cabinet with four drawers;
g. shelving with a total length of 3 m and of nominal width 300 mm;
h. two opening windows and total glazed area of at least 1.5 m^2;
i. adequate blinds covering all glazed areas;
j. adequate lighting;
k. two wall-mounted 3-pin 16A double socket electrical outlets;
l. one refrigerator of at least 100 litre capacity (in three of the offices)
m. one kettle of at least 2 litre capacity
n. an air conditioning unit (capable of heating and cooling) of at least 12 000 BTU/h capacity;
o. adequate multiplugs, adapters and extension cables necessary for connecting all appliances (and office equipment listed elsewhere) to mains power simultaneously, while still having two available 3-pin 16A sockets.

Two ablution facilities provided for the sole use of the Employer's Agent or his representative. The facilities provided shall conform to the local health authority requirements as applicable, and the Contractor shall pay all sanitary fees and charges.

One conference room for conducting meetings, with floor area of at least 6 m x 7 m in plan. The conference room shall include/contain:

a. one large meeting table to seat sixteen people, with a table top height of between 0.7 m to 0.8 m (4x identical tables may be pushed and secured together to form the sixteen-seater table);
b. sixteen chairs;
c. one A0 sized drawing table;
d. four wall-mounted 16A double socket electrical outlets ;
e. one 5m extension cable, for the exclusive use of the Employer's Agent and his staff or guests at the meeting table;
f. adequate multiplugs, adapters and extension cables necessary for connecting any equipment that is to be installed in the conference room (such as printers and WiFi specified elsewhere) to mains power simultaneously, while still having two available 3-pin 16A sockets;
g. two air conditioning units (capable of heating and cooling) of at least 12 000 BTU/h capacity each;
h. a personal, sturdy, portable folding table with height of between 65 and 75 cm, a length of between 60 and 80 cm and width of between 40 and 60 cm ("Lifetime Personal Table", "Bushtec Personal Adjustable Table", or equal approved);
i. a sturdy, plastic, folding chair.

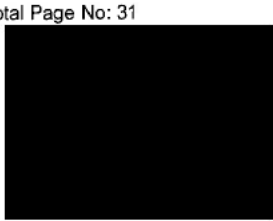
The buildings (i.e. offices, ablutions, conference room(s), etc.) shall have ceiling heights of at least 2.4 m (unless otherwise approved), shall be weatherproof and shall be provided with a ceiling and a lining to the walls, or equivalent insulation to provide comfortable working conditions. All floors shall either be wooden boarded floors that are at least 150 mm above the ground or floors covered with linoleum.

All windows shall be fitted with burglar proofing over the entire glazed area and with fly screens over the window openings. Each room, office and cubicle shall have an adequate door with a secure lock.

The buildings shall be fitted with wall-mounted fire extinguishers and safety signs in accordance with SANS 10400-T, but with no less one 4.5kg dry chemical powder fire extinguishers mounted in each office.

The Contractor shall further provide and pay for all necessary services required by these buildings, including providing water, electricity, sewage, rubbish disposal, etc.

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The buildings and their furnishings specified shall be for the exclusive use of the Employer's Agent and his/her staff. After the Employer's Agent has issued the Taking-Over Certificate or Certificate of Practical Completion (as applicable) and after the Contractor has completed, to the satisfaction of the Employer's Agent, all outstanding work and defects listed therein, ownership of the buildings and their furnishings shall revert to the Contractor who shall promptly remove them."

3.3 PARKING FOR VEHICLES (NEW SUBCLAUSE 3.3)

The Contractor shall provide and have ready when commencing with work on Site, and thereafter maintain, for the duration of construction, twelve (12) parking spaces of which six (6) shall be covered parking spaces. The parking spaces shall be for the exclusive use of the Employer's Agent, his staff and their guests, and shall include a pathway to the Employer's Agent's office.

Each parking space shall have a floor area of at least 20 m^2 in plan and shall be positioned so as to provide easy and convenient access to the Employer's Agent's office. All parking space floors and the pathway to the Employer's Agent's office shall be covered with a layer of crushed stone to alleviate dusty and muddy conditions.

After the Employer's Agent has issued the Taking-Over Certificate or Certificate of Practical Completion (as applicable) and after the Contractor has completed, to the satisfaction of the Employer's Agent, all outstanding work and defects listed therein, the Contractor shall promptly remove the parking spaces and pathways from Site."

3.4 PROTECTIVE CLOTHING (NEW SUBCLAUSE 3.4)

The Contractor shall provide and have ready when commencing with work on site, and thereafter maintain and replace (as necessary) for the duration of construction, the following:

a. ten sets of safety helmets;
b. ten sets of safety shoes (of sizes as required);
c. ten sets of gumboots (of sizes as required);
d. ten hi-vis vests (of sizes as required).

This protective clothing and equipment shall be for the exclusive use of the Employer's Agent, the Employer's Agent's site staff and their visitors.

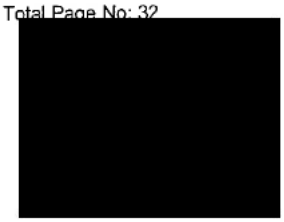
3.5 ELECTRICITY SUPPLY FOR THE EMPLOYER'S AGENT (NEW SUBCLAUSE 3.5)

The Contractor shall provide and pay for electricity required by these buildings, including adequate backup generation during periods of failure of mains supply or load shedding. The electrical supply shall be adequate to power all facilities, lights, appliances, office equipment (listed elsewhere) and aircons simultaneously. The changeover from mains power to backup generation shall be seamless for the Employer's Agent and his staff (i.e. backup generation shall power the same electrical outlets as the mains power, thus not requiring the Employer's Agent to switch plugs at changeover). The Contractor shall be responsible for ensuring that these services are available and reliable during normal working hours.

All electricity supply to the Employer's Agent's office(s), whether provided by the Contractor by way of a reticulated supply from a local authority or other authorised electricity supply, or by way of on-site generators, shall be regulated by the Contractor to within limits such as to prevent damage due to fluctuations in the electrical current supply that may occur to any electrical plant and equipment provided by the Contractor or the Employer's Agent.

The Contractor shall be liable for and pay all costs incurred for the repair or replacement of any electrical equipment damaged due to poor regulation of electrical supply. Reliance by the Contractor on the regulation of the electrical supply by the supplier or on current regulators fitted to generators shall not absolve the Contractor of his liabilities in terms of this Subclause and, where appropriate, the Contractor shall provide and install at his own cost, all such electrical current-regulating equipment as is necessary to prevent damage to the said equipment.

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4. PLANT (CLAUSE 4)

4.1 INTERNET (NEW SUBCLAUSE 4.2)

The Contractor shall provide and have ready when commencing with work on Site, and thereafter maintain for the duration of construction, an uncapped, unthrottled and unshaped internet data facility at each of the Employer's Agents offices. The data facility shall:

a. have data-transfer speeds of at least 20 Mbps download and 10 Mbps upload,
b. be provided with a password protected WiFi network (WiFi 4 or later standard),
c. have a WiFi range covering, at minimum, the Employer's Agent's offices, the conference room, and 10m beyond these, and in which range the WiFi connection must be stable at a speed of at least 50Mbps to all devices supplied by the Contractor.

The Contractor shall insure the internet connection equipment against loss or damage from whatever cause arising and shall ensure that all internet accounts are promptly paid on the due dates for payment. In addition, the Contractor shall indemnify the Employer and the Employer's Agent and his staff against all claims for loss, breakage or theft of such equipment. The Contractor shall further, at his own cost, ensure the prompt repair of the equipment provided under this clause, when reasonably required by the Employer's Agent.

The Contractor shall settle the accounts for all costs related to the above.

4.2 PRINTERS (NEW SUBCLAUSE 4.3)

The Contractor shall provide and have ready when commencing with work on Site, and thereafter maintain and service for the duration of construction, the following:

One new A3 multi-function printer. The printer shall:

a. be capable of printing, photocopying and scanning size A3 and A4 documents in full colour;
b. be WiFi enabled, connected to the WiFi network provided for the Employer's Agent's offices and set up for printing and scanning over the WiFi network;
c. be internet enabled and capable of (and set up for) scanning directly to email;
d. have a USB interface (and be supplied with the required cable) for connecting directly to a computer for printing and scanning over the USB interface;
e. be provided on a suitable table, supplied with the required cables and installed in the conference room;
f. be provided with an adequate supply of paper (both A3 and A4 sizes) and ink cartridges (black and colour);
g. be of the Hewlett-Packard OfficeJet colour printer series or equal approved;

One new A4 laser printer. The printer shall:

a. be of the laser type and use a toner cartridge;
b. be capable of printing A4 black and white documents;
c. be WiFi enabled, connected to the WiFi network provided for the Employer's Agent's offices and set up for printing over the WiFi network;
d. also have a USB interface (and be supplied with the required cable) for connecting directly to a computer for printing over the USB interface;
e. be provided on a suitable table, supplied with the required cables and installed in the conference room;
f. be provided with an adequate supply of A4 paper and laser cartridges (black toner);
g. be of the Hewlett-Packard LaserJet printer series or equal approved;

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The Contractor shall ensure that all printers are compatible with the Employer's Agent's laptop computers and the WiFi connections provided by the Contractor. All printers shall be supplied with the necessary software and drivers to perform the requirements listed, which shall be installed and set up by the Contractor on the laptop computers of the Employer's Agent and his staff.

The Contractor shall provide all paper, ink cartridges and other printer consumables required by the Employer's Agent. All printers provided shall be kept fully serviceable at all times by the Contractor. Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Employer's Agent's staff.

After the Employer's Agent has issued the Taking-Over Certificate or Certificate of Practical Completion (as applicable) and after the Contractor has completed, to the satisfaction of the Employer's Agent, all outstanding work and defects listed therein, ownership of the printers and their accessories shall revert to the Contractor who shall remove them."

4.3 MEDICAL FACILITIES AND SAFETY EQUIPMENT (NEW SUBCLAUSE 4.4)

The Contractor shall make the first aid services and such personal safety equipment and facilities as are required in terms of SANS 1200 A, available to the Employer's Agent and his site staff.

4.4 SURVEY EQUIPMENT (NEW SUBCLAUSE 4.5)

The Contractor shall provide and have ready when commencing with work on Site, and thereafter maintain and service for the duration of construction, the following survey equipment:

h. One automatic reading Employer's Agent's level plus tripod
i. One levelling staff (5m long, 1cm graduations)
j. One staff angle bubble
k. One metal change-point for levelling
l. One spirit level (one metre long)
m. One hammer (2kg) with steel or wooden pegs as necessary
n. Two canvas carry bags
o. One 100m Stilon or similar approved measuring tape
p. Two 5,0m (or longer) retractable steel tapes

The Contractor shall provide proof, at the start of the Contract, that the Employer's Agent's level has recently been serviced by an acceptable institution and shall, throughout the period of construction, service and maintain all survey equipment. He shall keep the equipment continuously insured against any loss, damage, or breakage, and he shall indemnify the Employer and the Employer's Agent against all claims for loss, breakage or theft of such equipment.

The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Employer's Agent's staff.

Where required by the Employer's Agent, the Contractor shall at his own cost, promptly arrange for the recalibration of survey equipment provided.

The instruments shall be provided for the exclusive use of the Employer's Agent. The Contractor shall maintain the equipment in good working order and keep it clean until the completion of the Works.

After the Employer's Agent has issued the Taking-Over Certificate or Certificate of Practical Completion (as applicable) and after the Contractor has completed, to the satisfaction of the Employer's Agent, all outstanding work and defects listed therein, the survey equipment, as listed above, shall revert to the Contractor.

4.5 WEATHER MONITORING EQUIPMENT (NEW SUBCLAUSE 4.6)

The Contractor shall provide one weather monitoring station to be installed at the site camp, or in the case where the site camp in not in proximity of the works, at a location approved by the Employer's Agent.

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[redacted]

The weather monitoring station shall be capable of recording wind speed, ambient temperature and rainfall with and accuracy of ± 1%. The weather monitoring station shall log, and store recorded data at intervals not exceeding 1 minute. The weather station shall be connected to the internet and the recorded data shall be stored, at intervals not exceeding 1 minute, on a cloud-based Weather Server that can be accessed by the Employer's Agent through the internet. The Weather Monitoring Station shall have a backup power supply and onboard storage to ensure that data is not lost during a power or network outage. The backup power supply shall be sufficient to power the weather station for 12 hours. The onboard storage shall have sufficient capacity to store data for at least two days.

In addition to the weather monitoring station, three (3) rain gauges, for the exclusive use of the Employer's Agent, shall be positioned in places approved by the Employer's Agent.

The rain gauge provided shall only be emptied by the Employer's Agent unless he approves one of the Contractor's staff to empty the gauge. Unless otherwise agreed, the Contractor shall accompany the Employer's Agent to take and agree on the rainfall measurements and witness emptying of the gauge daily. Should the Contractor or his staff tamper with or empty the rain gauge without prior approval of the Employer's Agent, the measurement for the preceding or following period will be taken to be zero, whichever period is most appropriate in the opinion of the Employer's Agent.

5. CONSTRUCTION (CLAUSE 5)

5.1 NAMEBOARDS (SUBCLAUSE 5.1)

Replace the contents of this Subclause with the following:

"The position of all nameboards will be subject to the Employer's Agent's approval and must in no way obstruct sight lines for road, rail or pedestrian traffic. All arrangements regarding permission and approval from the controlling authority as far as locations are concerned, are the Contractor's responsibility. The Contractor shall keep the nameboards in good state of repair for the duration of the Contract and he shall remove them once the Defects Notification Period(s) expire and before the Performance Certificate is issued."

5.2 ENGINEER'S OFFICE(S) (SUBCLAUSE 5.2)

Replace the contents of this Subclause with the following:

"Throughout the Contract period, the Contractor shall provide proper maintenance of the offices, ablutions, and conference room(s), parking area(s) and their approaches, and shall keep them clean, hygienic and sanitary.

5.3 KEY PERSONNEL (SUBCLAUSE 5.3)

Add at the end of this Subclause:

"The Contractor shall inform the Employer's Agent of the person to whom he has assigned duties with respect to the Site(s) in terms of the Occupational Health and Safety Act and the person(s) who are in possession of a valid certificate of competency in first aid. The Contractor shall promptly give copies of the minutes of the monthly site safety meetings to the Employer's Agent."

5.4 SURVEY ASSISTANTS (SUBCLAUSE 5.5)

Delete the first sentence and substitute with the following:

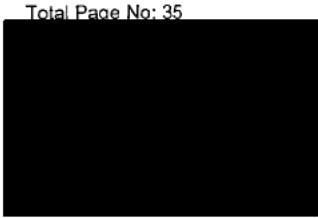
"The Contractor shall make available to the Employer's Agent two suitably educated labourers for use on and about the Site for survey and other work directed by the Employer's Agent at all reasonable times."

5.5 SITE INSTRUCTION BOOK (NEW SUBCLAUSE 5.6)

Unless the Employer's Agent supplies and chooses to make use of his own Site Instruction book, or the terms of contractual communication exclude the use of a Site Instruction book, the Contractor shall supply a carbon triplicate book as a Site Instruction book, which shall be used and replaced throughout the construction period.

The Site Instruction book shall be kept on Site and shall be accessible to both the Contractor and the Employer's Agent at all times. It shall be used:

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a. by the Employer's Agent for the purpose of writing day-to-day instructions, issuing of construction drawings and confirming any verbal information or instructions given to the Contractor.

b. by the Contractor for providing the Employer's Agent with any information regarding the construction of the Works which may be requested.

One copy of each site note issued shall remain in the book.

6. TOLERANCES (CLAUSE 6)

No amendments.

7. TESTING (CLAUSE 7)

No amendments.

8. MEASUREMENT AND PAYMENT (CLAUSE 8)

Delete the contents of Clause 8 and substitute with the following:

"Facilities for the Employer's Agent will not be measured and paid for separately, but all consolidated into two items, one item covering all fixed-charge requirements and the other covering all time-related requirements. The fixed-charge item will be scheduled under SANS 1200 A as Subclause 8.3.2.1 and the time-related item will be scheduled under SANS 1200 A as Subclause 8.4.2.1. The terms of Clauses 8 of SANS 1200 A shall apply.

In the case where a Taking-Over Certificate or Certificate of Practical Completion (as applicable) is issued with a list of outstanding work and defects, the items and responsibilities specified herein that are necessary to complete the outstanding work and remedy the defects, in the opinion of the Employer's Agent, shall not cease or be removed but shall remain and continue at the Contractor's own cost until the work is complete and defects remedied to the satisfaction of the Employer's Agent."

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1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATIONS (CLAUSE 2)

No Amendments.

3 MATERIALS (CLAUSE 3)

3.1 DISPOSAL OF MATERIAL (SUBCLAUSE 3.1)

Delete the contents of this Subclause and substitute the following:

"Material, that is not re-usable, obtained from clearing and grubbing and from the demolition of structures shall be disposed of at areas off site identified by the Contractor and approved by the Employer's Agent. Disposal of combustible material by burning will not be permitted.

Fencing wire shall be neatly wound into rolls or coils and all such wire, together with all re-usable material from structures, etc., shall be stacked at designated points.

The Contractor shall obtain his own dumping sites for the disposal of material and all transport costs shall be included in the rates tendered for site clearance."

4 PLANT (CLAUSE 4)

No Amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 AREAS TO BE CLEARED AND GRUBBED (SUBCLAUSE 5.1)

Add the following to the end of this Subclause:

"Notwithstanding the above, the Employer's Agent may, where particular areas are scarcely vegetated, order that the clearing and grubbing operation be totally or partially omitted, in which case no payment will be made under this section.

Unless otherwise ordered by the Employer's Agent, a sufficiently wide strip shall be cleared for pipeline routes for the execution of the works, including safe working space, stockpiling of backfill material, access, placement of pipes alongside the trench and stockpiling of topsoil material. Route pegs or markers shall not be destroyed or damaged during clearing operations. Th width cleared shall not extend more than the working widths indicated on the drawings.

The following applies to other clearing widths:

a) The width to be cleared for roads shall not exceed 0,5 m beyond the road footprint, including the toe of fill and top of cut.
b) The area to be cleared for the Works and stock pile areas shall not exceed the specified dimensions by a margin of 0,5 m measured from the perimeter.

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Payment will then only be made for excavation included under the relevant earthworks section.

5.2 CUTTING OF TREES (SUBCLAUSE 5.2)

5.2.1 PRESERVATION OF TREES (SUBCLAUSE 5.2.3)

5.2.1.1 INDIVIDUAL TREES (SUBCLAUSE 5.2.3.1)

Replace the last sentence of Subclause 5.2.3.2 with the following:

"An amount stated in the Environmental Management Plan will be deducted from moneys due to the Contractor as a penalty for every tree that is damaged or removed unnecessarily."

5.3 RECLEARING OF VEGETATION (SUBCLAUSE 5.5)

Add the following to the end of this Subclause:

"When areas have to be re-cleared on the written instructions of the Employer's Agent, such re-clearing shall be carried out at the Contractor's own cost and the Contractor is therefore advised not to clear areas at such an early stage that re-clearing may become necessary.

Clearing of vegetation shall be done in accordance with the Construction Phase Environmental Management Plan (cEMP)"

5.4 CONSERVATION OF TOPSOIL (SUBCLAUSE 5.6)

Add the following to Subclause 5.6:

"Topsoil up to a depth of 150mm, if available or where directed by Employer's Agent on site, shall be removed from the above specified cleared areas and stockpiled on approved sites for later reuse.

Until required for spreading, the stockpiles of topsoil material shall be stabilized by watering or other approved means.

Conservation of Topsoil shall be done in accordance with the Construction Phase Environmental Management Plan (cEMP)"

6 TOLERANCES (CLAUSE 6)

No Amendments.

7 TESTING (CLAUSE 7)

No Amendments.

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8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUB-CLAUSE 8.1)

Add the following to the end of this Subclause:

"The Contractor shall survey the site after completion of Site Clearance and agree with the Employer's Agent the levels to be used for earthworks quantity calculations."

8.2 SCHEDULED ITEMS (SUB-CLAUSE 8.2)

8.2.1 Clear and grub (Subclause 8.2.1)..... Unit : m^2

Replace the first line of subclause 8.2.1 with the following:

"The area designated by the Employer's Agent to be cleared and grubbed will be measured in square metre to the nearest square metre or, "

8.2.2 Remove, grub, and relocate on site large trees and tree stumps of girth (Subclause 8.2.2)

Replace the fourth line of subclause 8.2.2 with the following:

"The rate shall cover the cost of clearing (relocating if required by Employer's Agent) and grubbing trees and stumps of all sizes, cutting branches, "

8.2.3 Take down and dispose of existing fences (Subclause 8.2.5)

Replace Subclause 8.2.5 with the following:

"The rate shall cover the cost of taking down the wire fence and posts, including supplying clean backfill material (sand) and compacting in layers not exceeding 150mm thick to 95% MOD AASHTO. All materials, including any spoil material is to be loaded and disposed of at an approved dump site"

The unit rate of measurement shall be meter ..... Unit : m

8.2.4 Dismantle, remove, and reinstate pipelines, electricity transmission lines, cables, etc. (Subclause 8.2.7)

Replace the contents of Subclause 8.2.7 with the following:

"The tendered rates shall include full compensation for the detection, disconnection, removal, stockpiling, safeguarding, reinstatement and reconnection of services, including all necessary excavation, bedding, concrete bases and backfilling. In the event of the contractor damaging any of the services he will replace it at his own cost."

The unit rate of measurement shall be meter ..... Unit : m

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8.2.5 Demolish and remove structures/buildings and dismantle steelwork, etc. (Subclause 8.2.8)
For this Subclause, change the unit of measure from "Unit: Sum" to "Unit: Sum, No., m, m^2 or m^3".

Replace the second paragraph of Subclause 8.2.8 with the following:

"The rate shall cover the cost of excavating around the structure, demolishing the structure, disposal of excavated material and rubble, and backfilling of the hole with clean sand in layers of 300 mm including compaction to 100% of MOD AASHTO. The building rubble with then be cleaned of any steel, tiles, glass, asbestos or any other hazardous material. The building rubble clear of any steel, tiles, glass, asbestos or any other hazardous material will be disposed (including transport) of at a disposal site provided by the Contractor off site. Any steel, tiles and glass will be disposed of at a suitable disposal site selected by the Contractor and subject to approval of the Employer's Agent. The careful removal of all mechanical and electrical equipment and stored on site at a suitable area selected by the Employer's Agent shall be included within this rate. The disposal of asbestos or any other hazardous material will be in accordance with SANS 1200 A and its amendments. Different structures will be listed separately in the Schedule of Quantities."

Add the following to the end of this Subclause:

"Where m, m^2 or m^3 are used as a unit of measure, the length, area or volume (as applicable) shall be the measurements prior to demolition."

8.2.6 Extra over item 8.2.8 for removing hazardous materials off-site (Subclause 8.2.8.a)
The rate shall cover all costs involved in removing, transporting and disposal charges of any material deemed hazardous by the Employer's Agent to an approved hazardous landfill site in accordance with the Health and Safety specifications.

The unit rate of measurement shall be per square meter or cubic meter .....Unit : m^2 or m^3

8.2.7 Remove topsoil to nominal depth of 150 mm and stockpile/spoil (Subclause 8.2.10)

Add the following to Subclause 8.2.10 :

"The rate tendered for topsoil shall also cover the cost of stabilizing and protecting the stockpiles of topsoil or spoil at the designated spoil site(s) until required for use elsewhere."

Add the following New Subclauses:

8.2.8 Take down and re-erect existing fences (New Subclause 8.2.11) .....Unit : m

The rate shall cover the cost of taking down the fences, coiling wire, sorting, stacking, and guarding all material, the cost of loading, transporting and off-loading such material, the cost of re-erecting the fence in its original position using the dismantled material and the cost of temporary bracing the sections of fence not taken down.

The rate shall also cover the cost of using new tying wire but not the cost of any other new material that may have to be used on the written instructions of the Employer's Agent.

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8.2.9 Saw cutting of existing concrete (average 150mm thick) (New subclause 8.2.12).....Unit : m

"The unit of measurement shall be the metre of cut as instructed by the Employer's Agent.

The tendered rates shall include full compensation for all labour, constructional plant and material required, for sawing or cutting costs, and for all incidentals of cutting or sawing in accordance with the instructions of the Employer's Agent."

8.2.10 Saw cutting of existing asphalt up to 50mm thick (New subclause 8.2.13) .....Unit : m

" The unit of measurement shall be the metre of cut as instructed by the Employer's Agent.

The tendered rates shall include full compensation for all labour, constructional plant and material required, for sawing or cutting costs, and for all incidentals of cutting or sawing in accordance with the instructions of the Employer's Agent."

8.2.11 Remove and dispose of asphalt surfacing (New subclause 8.2.14)..... Unit : m^2

"The rate tendered shall cover the provision of all labour and equipment necessary to remove and dispose of asphalt surfacing, regardless of volume (saw-cutting will be compensated for under item 8.2.12)."

8.2.12 Remove and dispose of concrete surfacing (average 150mm thick) (New subclause 8.2.15)... ..... Unit : m^2

"The rate tendered shall cover the provision of all labour and equipment necessary to remove and dispose of concrete surfacing, regardless of volume (saw-cutting will be compensated for under item 8.2.13)."

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1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATIONS (CLAUSE 2)

2.1 SUPPORTING SPECIFICATIONS (SUBCLAUSE 2.1)

Replace Subclause 2.1.2 with the following:

"Any of the other SANS 1200 specifications may form part of the Contract documents."

2.2 DEFINITIONS (SUBCLAUSE 2.3)

Replace the word and the definition for "Borrow" *with the following:*

"**Borrow material**: Material, other than material obtained from excavations required for the works, obtained from sources such as borrow pits or the authorised widening of excavations. 'Borrow' shall have a corresponding meaning."

Replace the definition for "Specified density" *with the following:*

"**Specified density**: The specified dry density expressed as a percentage of modified AASHTO dry density."

Replace the definition for "Stockpile" *with the following:*

"**Stockpile** (verb): The process of selecting and, when necessary, loading, transporting and off-loading material in a designated area for later use for a specific purpose."

Add the following definitions:

"**Commercial source:** A source of material provided by the Contractor, not the Employer, and including any borrow pit, provided by the Contractor.

Fill: An embankment or terrace constructed of material obtained from commercial sources, excavations or borrow pits. In roads it includes the earthworks up to the underside of the selected subgrade level.

Fill (material): Material used for the construction of an embankment or terrace.

Roadbed: The natural in situ material on which the fill or, in the absence of fill, the pavement layers are constructed."

3 MATERIALS (CLAUSE 3)

3.1 CLASSIFICATION FOR EXCAVATION PURPOSES (SUBCLAUSE 3.1)

3.1.1 Method of classifying (Subclause 3.1.1)

Add the following:

"The classification of material other than 'soft excavation' shall be agreed upon before excavation may commence.

The Contractor shall immediately inform the Employer's Agent if and when the nature of the material being excavated changes to such an extent that a new classification is warranted for further excavation. Failure on the part of the Contractor to advise the Employer's Agent in good time shall entitle the Employer's Agent to reclassify, at his discretion, such excavated material."

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[redacted]

3.1.2 Classes of excavation (Subclause 3.1.2)

Replace the first sentence with the following:

"Notwithstanding the provisions of SANS Subclause 3.1.2, the materials excavated, other than hard rock, will not be classified for the purposes of measurement and payment. The unit rate for excavation shall cover the cost of excavation in all materials with the only extra-over item payable being that for excavation in hard rock. Boulders will be classified as hard rock."

3.2 CLASSIFICATION FOR PLACING PURPOSES (SUBCLAUSE 3.2)

3.2.1 Material Suitable for Backfill or Fill against Structures (Subclause 3.2.3)

Replace the contents of Subclause 3.2.3 with the following:

"Material used for backfill behind structures shall generally be the material excavated, subject to the following conditions:

(a) The material shall not contain more than 10% stones and hard rock fragments retained on a 50mm sieve.
(b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment.
(c) The liquid limit of the material shall not exceed 40, neither shall the PI exceed 18.
(d) The minimum modified AASHTO density shall be 93%."

3.2.2 Selected material for backfill of conservancy tank (New Subclause 3.2.4)

Selected material shall be graded granular material having a maximum particle size of 25mm and a PI not exceeding 15."

3.3 SELECTION (SUBCLAUSE 3.3)

3.3.1 General (Subclause 3.3.1)

Replace the second paragraph of Subclause 3.3.1 with the following :

"The Contractor shall deal selectively with materials from all excavations to ensure that no acceptable backfill or bedding material is contaminated by material unfit for use. No additional payment shall be made in this regard and all costs related to the above selection process shall be included in the applicable payment items. Should useful material be contaminated to such an extent that it is regarded as unfit for use the Contractor shall at his own cost dispose of this material and replace it with material of an equivalent standard to the acceptable in situ material."

3.3.2 Backfilling and embankments (Subclause 3.3.2)

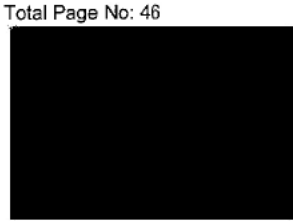
Add to the end of this Subclause the following:

With reference to the last line of this subclause the material to be used for backfilling shall be either 15MPa/20mm concrete or material complying with Subclause 3.2.3 compacted in 150mm layers to 90% of modified AASHTO maximum density, as ordered on site.

Add the following New Subclause:

3.3.3 Selection in Borrow Pits and Excavations (New Subclause 3.3.3)

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Approval of a borrow area for a certain purpose does not necessarily mean that all the material in that area is suitable for the specified purpose. What it does mean is that the borrow area contains some suitable material. The onus shall rest on the Contractor to ensure that only material that is indeed suitable is removed and used for the specified purpose.

When the Contractor has to select excavated material for a specific purpose, the above provisions relating to borrow areas shall apply mutatis mutandis to excavations.

The Contractor shall not waste or contaminate material that has been selected for a specific purpose."

4 PLANT (CLAUSE 4)

4.1 DETECTORS (SUBCLAUSE 4.4)

Replace the contents of this Subclause with the following:

"The Contractor shall, for the purposes of detecting and locating underground services in accordance with the provisions of Subclause 5.4 of SANS 1200 A and Subclause 5.1.2 of SANS 1200 D, at his own cost, except where scheduled separately, provide and use detecting equipment which is suitable for the detection of underground cables and pipes."

Add the following new Subclause:

4.2 RESTRICTION ON USE OF PLANT (NEW SUBCLAUSE 4.5)

Where the Contractor finds it impractical to use mechanical plant for excavation or to complete portions of the work due to restrictions caused by difficult access or the presence of existing structures, pipelines or services shown on tender drawings, the Contractor will be deemed to have satisfied himself as to the alternative requirements when entering rates against the appropriate items in the Schedule of Quantities as no claim for extra payment based on the inability to use plant in such circumstances will be considered."

5 CONSTRUCTION (CLAUSE 5)

5.1 PRECAUTIONS (SUBCLAUSE 5.1)

5.1.1 Safety (Subclause 5.1.1)

5.1.1.1 Barricading and lighting (Subclause 5.1.1.1)

Replace "Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)" *with* "Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

5.1.1.2 Safeguarding of excavations (Subclause 5.1.1.2)

Replace "Machinery and Occupational Safety Act" *with* "Occupational Health and Safety Act, 1993 (Act 85 of 1993) and Construction Regulations 2014."

Add the following to paragraph (b) (1):

"Payment for supporting the sides of excavations and trenches shall be deemed to be included in the rates tendered for excavations. No separate payment will be made in this regard, and it will be the Contractor's responsibility to ensure the safety and stability of all excavations.
Where trenches have to be widened to accommodate manholes, junction boxes, etc., the cost of supporting the vertical sides of such additional excavations will be deemed to be included in the rates tendered for excavation."

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Add the following to paragraph (b) (2):

"The slope of the sides of an excavation or trench may never be steeper than 60° to the horizontal and all costs incurred to slope the sides of an excavation or trench will, irrespective of the angle of the slope, be deemed to be included in the rates quoted for excavation."

Add the following sub-paragraph:
"(g) The Contractor or his agent or his representative shall not require or allow any person to work under unsupported overhanging material or in an excavation which is more than 1.5 m deep, and any excavation which has not been adequately supported or braced if there is a danger of the overhanging material or the sides of the excavation collapsing. The support, shoring or bracing to be designed and constructed by the Contractor, shall be strong and sturdy enough to support the sides of the excavation in question."

5.1.1.3 Explosives (Subclause 5.1.1.3)

Replace the contents of this Subclause with the following:

"The Contractor will generally be permitted to use explosives for breaking up hard material during excavations, for demolishing existing structures, and for other purposes where explosives are normally required, subject to the following conditions:

(a) The Employer's Agent may prohibit the use of explosives in cases where, in his opinion, the risk of injury to persons or damage to property or to adjoining structures is too high.

(b) The Employer's Agent's prior written approval shall be obtained for each and every blasting operation. This approval may be withheld if the Contractor does not use explosives responsibly and carefully.

(c) The Contractor shall comply fully with the requirements of the Explosives Act, 1997 (Act No 83 of 1997) and all other legislation and regulations as may be applicable to blasting and the use of explosives.

(d) Before blasting is undertaken, the Contractor shall satisfy the Employer's Agent that he has established whether or not the insurers concerned require pre- and post-blasting inspections of buildings and structures within a certain radius of the proposed blasting.
Should such inspections be required, the Contractor shall, together with the Employer's Agent and the insurer, examine and measure the buildings, houses or structures in the vicinity of the proposed blasting site and establish and record, together with the owner, lessee or occupier, the extent of any existing cracking or damage before blasting operations commence. It is advised that a photographic record will be required of neighbouring structures before blasting commences. It shall be the responsibility of the Contractor to make good at his own expense any further damage to such houses, buildings or structures which is a result of the blasting.

(e) When there is a possibility of damage to power and telephone lines or any other services or property, the Contractor shall adapt his method of blasting and the size of the charges and shall use adequate protective measures (e.g. cover-blasting) to reduce the risk of damage.

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(f) All accidents, injury to persons and animals and damage to property shall be reported to the Employer's Agent in detail and in writing as soon as is practicable.

(g) The Employer's Agent shall be given 24 hours' notice by the Contractor before each blasting operation is carried out.

(h) When blasting to specified profiles, the Contractor shall so arrange the holes and charges so that the resulting exposed surfaces are as sound as the nature of the material permits. The Contractor shall make good, at his own expense, any additional excavation necessitated by the shattering of rock in excess of any overbreak allowances specified or given on any Drawing.

Notwithstanding the Contractor's compliance with the above provisions, the Contractor shall remain liable for any injury to persons and animals and loss of or damage to property occurring as a result of blasting operations.

Blasting shall only be permitted upon the written approval by the Employer's Agent."

5.1.2 Existing services (Subclause 5.1.2)

5.1.2.1 Detection, location, and exposure (Subclause 5.1.2.2)

Replace the contents of this Subclause with the following:

"The exposure by the Contractor of underground services, as required in terms of Subclause 5.4 of SANS 1200 A shall be carried out by careful hand excavation at such positions and to such dimensions as are agreed to by the Employer's Agent.

Unless otherwise instructed or agreed by the Employer's Agent, no service shall be left exposed after its exact position has been determined and all excavations carried out for the purposes of exposing underground services shall be promptly backfilled and compacted to the following densities:

(a) In roadways: 95% Mod AASHTO density; and
(b) In all other areas: 93% Mod AASHTO density.

Where hand excavations to expose underground services have to be carried out in roadways, the Contractor shall reinstate the road layerworks in accordance with the provisions of Subclause 5.9 of SANS 1200 DB.

Payment in respect of exposing the services by means of hand excavation as described above, will be made in accordance with Subclause 8.3.8.1.

Payment in respect of reinstating layerworks in roadways will be made in accordance with Subclause 8.3.6.1 of SANS 1200 DB."

5.1.2.2 Protection of cables (Subclause 5.1.2.3)

Replace the contents of this Subclause with the following:

"Further to the requirements of Subclause 5.4.2 of SANS 1200 A, major excavating equipment and other plant shall not be operated dangerously close to known services. Where necessary, excavation in close

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proximity to known services shall be carefully carried out with suitable hand tools, excluding picks wherever their use could damage the services. No additional payment will apply to such more difficult work.

Should any service not being a known service be discovered or encountered during the course of the Contract, the Contractor shall, in addition to complying with the requirements of subclause 5.4.2 of SANS 1200 A, immediately notify the Employer's Agent thereof and implement such measures as will prevent damage of such service or, if it was damaged in the course of discovery, will prevent and minimise the occurrence of any further damage occurring."

5.1.2.3 Negligence (Subclause 5.1.2.4)

Delete the contents within this and add the following:

"The Contractor shall not repair any service damaged due to his negligence. Where the damage is the result of the Contractor's negligence, he shall bear all costs of the repairs undertaken by the owner, as well as the costs of associated damages."

5.1.3 Stormwater and groundwater (Subclause 5.1.3)

Add the following:

"The Contractor shall, where applicable and at the earliest practicable opportunity, install the permanent drainage specified or shown on the Drawings and shall also provide the temporary drainage required to protect the works."

5.1.4 Excavated material not to endanger or interfere (Subclause 5.1.4.3)

Delete the last sentence and substitute with the following:

"All material that is unsuitable or not required for backfilling shall be disposed of at the approved disposal sites. No additional payment will be made for these activities."

5.1.5 Road traffic control (Subclause 5.1.6)

Delete the contents of Clause 5.1.6 and replace with the following:

"The provisions of Subclause 5.2.3 of SANS 1200A shall apply as applicable. Where the work affects the operation or safety of public road traffic, vehicular and/or pedestrians in addition, to complying with the requirements of Subclause 5.1.1.1, the Contractor shall provide, erect and maintain traffic signs, personnel and equipment that conform to the requirements, layout and guidelines of the "South African Road Traffic Signs Manual", as well as the Site Manual entitled "Safety at Roadworks in Urban Areas" as published by the Department of Transport, in number and in layout, as shown in these manuals.

Where necessary and as shown in these manuals, warning lights, an adequate number of flagmen and appropriate barricades, clearly visible to oncoming traffic at all times of the day and night shall be provided. If steel drums are used for this purpose, they shall be ballasted with soil, sand or stones and the outside shall be whitewashed and provided with retro-reflective material (in the case of tape, of minimum width 10mm), red on the left-hand side facing oncoming traffic and white on the right-hand side. The drums shall be maintained in a clean and effective condition and no stones shall be placed on them.

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No direct payment will be made for the cost of providing and complying to the aforementioned. Payment will be deemed to be covered by the rates and sums tendered and paid for the various items of work included under the Contract."

5.2 METHODS AND PROCEDURES (SUBCLAUSE 5.2)

5.2.1 Site Preparation (Subclause 5.2.1)

5.2.1.1 Conservation of topsoil (Subclause 5.2.1.2)

Delete this Subclause and replace with:

"When so scheduled and when there is suitable topsoil within the limits of the area to be cleared, the Contractor shall remove, and conserve topsoil in accordance with the Construction Phase Environmental Management Programme (cEMP). The Contractor will not be required to remove topsoil from any area in which the average depth of soil is less than 150 mm."

5.2.2 Excavation (Subclause 5.2.2)

5.2.2.1 Excavation for general earthworks and for structures (Subclause 5.2.2.1)

Add the following paragraph to the end of paragraph (b):

"When the nature of the material precludes the above procedure or where structural concrete (i.e. reinforced concrete and concrete for any structural element) is to be cast in excavations, additional excavations shall be carried out to provide working space for the erection of formwork. The provision of working space (see Subclause 8.3.5) will not be measured for payment. "

Replace the first sentence of paragraph (e) with the following:

"Where excavations have been carried below the authorised levels, the Contractor shall backfill such excavations to the correct level with approved sand fill from commercial sources compacted to 100% of modified AASHTO density or approved gravel compacted to 93% of modified AASHTO density or to the density of the surrounding material, whichever is the higher density. The cost of the remedial measures shall be for the Contractor's account.

Where backfilling is required below structures, either due to over-excavation or where ordered by the Employer's Agent, such backfill shall be mass concrete of Grade 15 MPa/19 mm or no-fines concrete, as directed by the Employer's Agent. Backfilling with 5% cement stabilized sand (typically equates to 75kg cement per m^3 of backfill) compacted to 100% MOD AASHTO in 150mm layers may be appropriate for use under certain structures, if approved by the Employer's Agent or where indicated on the drawings. The cement stabilized sand to be thoroughly mixed in the presence of the Employer's Agent. The cost of backfilling due to over-excavation shall be for the Contractor's account.

Where the sides of excavations against which non-structural concrete is to be cast have been over-excavated or have collapsed partially, the Contractor shall retrim the excavations if necessary and, unless other remedial measures are agreed to by the Employer's Agent, shall cast the concrete, including the additional concrete that may be required as a result of the over-excavation or partial collapse. The cost of the additional concrete or remedial measures shall be for the Contractor's account."

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5.2.2.2 Disposal (Subclause 5.2.2.3)

Replace the second sentence of this Subclause with the following:

"The Contractor shall provide all necessary spoil sites for the spoiling of all surplus and unsuitable materials and shall make the necessary arrangements with the owner of the site where the material is disposed of and pay all charges and levies as may be applicable for the use of such spoil sites.

Every spoil site provided by the Contractor shall be approved by the local authority in whose area it is located, and the spoiling shall comply with the applicable statutory and municipal regulations as well as the requirements of the owner of the spoil site.'

5.2.2.3 Selection and stockpiling (New Subclause 5.2.2.4)

Approval or designation of the material in a particular borrow pit or excavation for a particular purpose does not imply that all the material in the borrow pit or excavation is suitable for the particular purpose to which the said approval or designation relates, nor that all material in the borrow pit or source should be used for the particular purpose. The Contractor shall select suitable material from that borrow pit or source, discard unsuitable material and reserve material for other purposes as necessary.

The Contractor shall organise and carry out his operations in such a manner as will prevent the contamination of suitable embankment and backfill material with unsuitable materials. Any excavated material which becomes, in the Employer's Agent's opinion, unsuitable for use in embankments or backfill as a result of contamination, shall be disposed of in a manner acceptable to the Employer's Agent and shall be replaced by the Contractor with materials acceptable to the Employer's Agent, all at the Contractor's cost.

When required, or when ordered by the Employer's Agent, material shall be stockpiled for later use. Granular (silty sand), clay (sandy clay) and rock shall be stockpiled separately. The additional costs for stockpiling material shall be paid to the Contractor in accordance with the provisions of 8.3.14.

5.2.2.4 Recording of original ground profiles (New Subclause 5.2.2.5)

The Contractor shall inform the Employer's Agent, in writing, at least 14 days before commencing any work which will result in a change in the topography of the site, whether such work be for the permanent works or for temporary works which the Contractor intends to execute for his own convenience. Thereupon, before commencing the work, the Contractor shall undertake and be assisted by the Employer's Agent in taking cross-sections of the original ground profiles at structures and a centreline survey of the pipeline or another approved method to determine the ground profiles of the entire area to be worked. In addition, all rock and/or foundation levels shall be recorded as the work proceeds.

The information so obtained shall be permanently recorded on a drawing or drawings which shall each be signed by both the Contractor and the Employer's Agent. The Contractor shall then provide the Employer's Agent with a reproducible copy of each drawing to serve as a permanent record both for the purpose of redesign, of pipeline vertical alignment, determining the quantities of excavation and earthworks carried out in the construction of the permanent works and the extent to which temporary works shall be removed or temporary excavations shall be refilled upon completion of the Works.

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5.2.3 Placing and compaction (Subclause 5.2.3)

5.2.3.1 Embankments (Subclause 5.2.3.1)

Replace the first sentence of the sixth paragraph with the following:

"Each layer shall be compacted at OMC to a density as specified and in the case of cohesive soil and 100% of modified AASHTO maximum density in the case of non-cohesive soil."

The material of each area of fill shall, unless otherwise approved, be deposited in layers of thickness, before compaction, not exceeding 150 mm. The material shall be spread to form a layer that is approximately uniform thickness and graded over the whole area of the fill site.

Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allowed to dry out to the correct moisture content before compaction is undertaken.

The Contractor shall ensure that stormwater will at all times be discharged uniformly over the full fill area or through specially prepared and protected drainage ditches to prevent scouring of the slopes."

5.2.3.2 Backfilling of trenches and backfilling or filling against structures (Subclause 5.2.3.2)

In Subclause 5.2.3.2 after the second last paragraph add the following:

"Each layer shall be compacted at OMC to a density of at least 93% MAMDD in the case of cohesive soils or 100% in the case of non-cohesive soils. Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allowed to dry out to the correct moisture content before compaction is undertaken.

The contractor shall ensure that stormwater will at all times be discharged uniformly over the full fill area or through specially prepared and protected drainage ditches to prevent scouring of the slopes."

5.2.4 Finishing

5.2.4.1 Topsoiling (Subclause 5.2.4.2)

Replace the last sentence with:

"The final thickness of the topsoil shall be 150mm or as directed by the Employer's Agent or as required on the Drawings."

5.2.4.2 Grass or other vegetation (Subclause 5.2.4.3)

Add the following at the end of the subclause:

"Unless stated otherwise in the Construction Phase Environmental Management Programme (cEMP) or landscaping specifications, the following shall be applicable to the rehabilitation of construction areas:

Hydroseeding

The following materials shall be used in hydroseeding:

(a) Fertilizer

The type of fertilizer to be used shall be 2:3:2 (22 + 2N) and superphosphate.

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(b) Grass seed

The following seed mixture at an application rate of not less than 45 kg of seed mixture per hectare, shall be used for tendering purposes, the final mix proportions shall be given to the successful Contractor:

10 kg	Cynodon dactylon
10 kg	Festuca rubra
6 kg	Lolium multiflorum
6 kg	Agrostis tenius
3 kg	Trifolium subterranean
4 kg	Dactylis glomerata
6 kg	Serredella
45 kg	Per hectare

Cellulose pulp shall be added to the hydroseeding mix at a rate of 25 kg of pulp per kilolitre of water used, except where otherwise instructed in respect of flat slopes.

Hydroseeding shall be carried out with an approved hydroseeding machine at a rate of application of not less than 45 kg of seed mixture per hectare, unless otherwise specified in the Project Specifications.

If the Contract starting time and program is such that the work cannot be executed within the Contract period, then the work shall be executed during the 12 month maintenance period.

Grass sods

Grass sods shall be 100% Cynodon dactylon. It shall be vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and other harmful matter.

(a) Cutting, lifting, and handling of grass sods

(1) Prior to cutting and lifting, the sod shall be inspected and approved in its original location by the Employer's Agent or the Landscape Architect. Under no circumstances shall any sodding work be done unless weather and soil conditions are suitable, as determined by the Employer's Agent or the Landscape Architect.

(2) Sods shall be cut by an approved mechanical sod cutter and cut to a thickness of not more than 40 mm nor less than 25 mm. Sod pieces shall be cut to 0,5 m² in area. The width shall be 300 mm or 450 mm.

(3) Sod shall be rolled or folded prior to lifting. Handling of sods shall be done in such a manner that will prevent tearing, breaking, drying or any other damage. All damaged pieces of sod shall be rejected by the Employer's Agent or the Landscape Architect.

(4) Sods shall be installed in place on the Site not more than 48 hours after cutting.

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(b) Sodding procedures

(1) Rolling: Rolling shall be done in 2 (two) directions perpendicular to each other. The roller shall be a hand roller weighing not more than 90 kg or less than 70 kg. Roll in such a manner so as to eliminate the necessity of walking on the finished grade.

(2) After rolling, check finished grading for depressions, lumps, or any other irregularities. Repair and re-roll all areas as directed by the Employer's Agent or the Landscape Architect.

(3) Moisten soil surface immediately before sod laying, as directed by the Employer's Agent or the Landscape Architect. Use a fine spray that will not cause a disturbance of the finished surface.

(4) Lay sod parallel to the direction of the slope and in a manner that will permit joints to alternate.

(5) Fit sod pieces together tightly so that no joint is visible and tamp sod firmly and evenly by hand. Peg sod where slope is greater than 1:3.

(6) During sod laying operation, protect all sods as it is laid and finished, from depressions, lumps or any other irregularities in the finished surface.

(7) After sodding is complete and has been approved, roll in the same manner as described above and to the satisfaction of the Employer's Agent or the Landscape Architect.

(8) Water all sodded areas immediately after final rolling with a fine spray to a depth of 100 mm.

(c) Scope of maintenance work

(1) Maintenance on the grassing shall begin when the planting commences and shall continue until Final Acceptance (three months after issue of Take-Over Certificate).

(2) Maintenance shall consist of mowing, watering, weeding, fertilising, disease and insect pest control, aerating, replacement of unacceptable material, topdressing, and any other procedure consistent with good horticultural practice.

(3) Maintenance personnel shall visit the Site on a minimum weekly basis during the three month maintenance period. A proposed maintenance schedule shall be submitted by the Contractor to the Landscape Architect for approval. Prior to any maintenance work commencing, all defects that may become apparent during this period shall be thoroughly investigated and rectified by the Contractor to the Employer's Agent or the Landscape Architect's satisfaction.

(4) The Contractor shall be responsible for the use of all materials, labour and equipment, and any injury to plant material caused by such material, labour and equipment, shall be corrected and repaired by the Contractor at no additional expense to the Client.

(d) Establishment and maintenance of the grass

(1) All planted or sodded areas shall be adequately watered at frequent and regular

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intervals in order to ensure proper growth until the area has established an acceptable cover and, thereafter, until the beginning of the Maintenance Period. The amount and frequency of watering shall be subject to the Employer's Agent or the Landscape Architect's approval.

(2) The Contractor shall mow the grass on all areas that have been grassed to maintain an average height of 30 mm or when instructed by the Landscape Architect, until the end of the Maintenance Period. All grass cuttings shall be collected and disposed of if so directed by the Employer's Agent or the Landscape Architect. Weeds shall be controlled by means of pulling, cutting, or any other approved means.

(3) The Contractor shall top dress areas planted with sods once during the Maintenance Period with approved topsoil mix and fertilizer appropriate to negate any deficiency, according to the growth and colour of the grass.

(4) Any bare patches where the plant material has not taken, or where it has been damaged, shall be recultivated, planted, or sodded at the Contractor's own expense.

(5) All plant areas shall have acceptable cover as defined below at the end of the Maintenance Period.

(6) An acceptable vegetation cover shall mean that no less than 75% of the area planted shall be covered and that there shall be no bare patches of more than 500 mm in maximum dimension.

(7) The Maintenance Period on the grassing shall last three (3) months.

(e) Weeding

Keep all planting areas free from weeds and undesirable grasses, by a method and materials approved by the Employer's Agent or the Landscape Architect.

(f) Topdressing

All lawn areas shall be top dressed as necessary, to remove any minor depressions and visible joints in the grass sods. Topdressing shall be as previously specified."

(h) Vegetation for constructed wetlands

Vegetation to be planted in constructed wetlands shall include the following species:

(1) *Phragmites australis* (50% by number)

(2) *Typha latifolia* (50% by number).

The final stem density of all plants shall be no less than 15 shoots / m^2.

Plant rhizomes shall be brought to site and transplanted into the wetland substrate layer. Planted rhizomes shall be watered daily when there is no flow through the wetland."

5.2.5 Transport for earthworks (Subclause 5.2.5)

Replace the contents of this Subclause with the following:

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"The transport of all materials, irrespective of the distance and source, shall be deemed to be free-haul, the cost of which is included in the Contractor's tendered rates and prices for importation or disposal of materials. No separate compensation shall apply for the transportation of and double handling of materials."

6 TOLERANCES (CLAUSE 6)

6.1 POSITION, DIMENSIONS, LEVELS, ETC. (SUBCLAUSE 6.1)

Add the following:

Bulk earthworks (Subclause 6.1)

The tolerances applicable to excavations for structural foundations (degree of accuracy I), as specified in Sub-clause 6.1(a) shall apply, provided no ponding areas or adverse grades result."

7 TESTING (CLAUSE 7)

7.1 TAKING AND TESTING OF SAMPLES (SUBCLAUSE 7.2)

Replace the contents of this Subclause with the following:

"The Contractor shall carry out sufficient tests on a regular basis as specified or as agreed between him and the Employer's Agent to determine whether the degree of compaction, and, where applicable, the quality of materials used, comply with the specifications, and shall submit the results of these tests to the Employer's Agent in a form approved by him. Should the Contractor conduct their own testing, a sample shall be verified by an independent laboratory (SANAS registered) at a frequency determined and agreed between the Employer's Agent and Contractor. The Employer's Agent may likewise carry out such tests.

Testing by the Employer's Agent will not relieve the Contractor of his obligations to provide materials and workmanship in accordance with the specifications.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

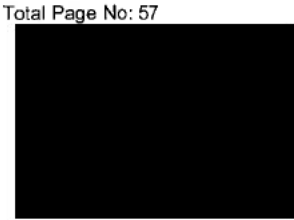
Replace the first sentence of Subclause 8.1.1 with the following:

"The basic principles of measurement and payment for all earthworks are that the rates tendered for excavation shall cover the cost of excavating at the Site and the re-use of the excavated material in backfilling, forming embankments, terraces, etc, or (where ordered) the replacement of excavated material with material from commercial sources for backfilling, and the cost of disposal of any surplus and unsuitable excavated material within the freehaul distance."

Add the following at the end of Subclause 8.1.3:

"The provision of working space (see Subclause 8.3.5) will not be measured for payment. Notwithstanding the provisions of Subclause 8.1.3, the Contractor shall make his own allowance for the excavation of any working space required for formwork or other purposes. The rates for restricted excavation shall also cover the costs of providing working space. All restricted excavation will be measured to the net dimensions of concrete floor slabs or other dimensions ordered by the Employer's Agent."

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8.2 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.2.1 Site preparation (Subclause 8.3.1)

8.2.1.1 Clear and strip site (Subclause 8.3.1.1)

Replace the contents of Subclause 8.3.1.1 with the following:

"Where site preparation such as clearing, grubbing, the removal of large trees or the removal and stockpiling of topsoil is required, the provisions and scheduled items of SANS 1200 C shall apply."

8.2.1.2 Remove topsoil to nominal depth 150mm (or stated depth), stockpile and maintain (Subclause 8.3.1.2)

In Subclause 8.3.1.2 change the unit to "m^3".

At the end of the first sentence in Subclause 8.3.1.2 add:

"including maintaining and vegetating the stockpiles."

8.2.2 Bulk excavation (Subclause 8.3.2)

Replace the contents of this Subclause with the following:

"(a) Excavate in all materials and use for berm, embankment or backfill, as ordered ..... Unit: m^3

The unit of measurement shall be the cubic metre measured in place in accordance with Subclause 8.2.

Separate items will be scheduled for embankments and backfills for different parts of the works.

The tendered rates shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 in addition to the cost of excavating in all materials, basic selecting, stockpiling, loading, transporting, off-loading, spreading, or backfilling, watering, compacting, final grading, complying with the requirements for tolerances, providing for testing, finishing, and tidying, all in accordance with the specifications.

No payments will be made to the Contractor under this item in respect of materials stockpiled by the Contractor on his own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by him in the course of executing the works, whether such stockpiling was avoidable or otherwise.

(b) Excavate in all materials and dispose of ..... Unit: m^3

The unit of measurement shall be the cubic metre of material excavated, measured in place in accordance with Subclause 8.2.

The tendered rates shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 in addition to the cost of excavating in all materials and disposing of these materials, the cost of complying with the requirements of Subclause 5.2.2.3, basic selecting, stockpiling, loading, transporting, off-loading at the spoil site, maintaining and finishing the spoil site and for all other incidental costs to excavate and dispose of the material, all in accordance with the specifications.

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No payments will be made to the Contractor under this item in respect of materials stockpiled by the Contractor on his own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by him in the course of executing the works, whether such stockpiling was avoidable or otherwise.

(c) Excavate in all materials and dispose of, and backfill with material from commercial sources (clean sand unless otherwise indicated) ..... Unit: m³

The unit of measurement shall be the cubic metre of material excavated on Site which is replaced with material from commercial sources, measured in place in accordance with Subclause 8.2. Separate items will be scheduled for different parts of the works and for importation from different sources.

The tendered rates shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 in addition to the cost of excavating in all materials and disposing of these materials, the cost of complying with the requirements of Subclause 5.2.2.3, basic selecting, loading, transporting, off-loading at the spoil site, maintaining and finishing the spoil site and for all other incidental costs to excavate and dispose of the material, all in accordance with the specifications.

The tendered rate shall also include for the costs of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or backfilling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications. No payment will be made for the removal of overburden or stockpiling at the commercial source."

(d) Extra over subitems 8.3.2(a), 8.3.2(b) and 8.3.2(c) for:

(1) Not applicable (VOID)
(2) Hard rock excavation ..... Unit: m³
(3) Boulder excavation, Class A ..... Unit: m³
(4) Boulder excavation, Class B ..... Unit: m³

The rate shall cover the additional cost of the operations enumerated in 8.3.2(a), 8.3.2(b) and 8.3.2(c) above for any portion of the excavation that is classified as hard rock, boulder excavation class A or boulder excavation class B as applicable. No extra-over payment will be made for excavation in material classified in terms of Subclause 3.1.2 as intermediate excavation. (See Drawing D-2.)"

8.2.3 Restricted excavation (Subclause 8.3.3)

Replace the sub-heading of 8.3.3(a) with:

"(a) Excavate for restricted foundations, footings, trenches, drains, buried infrastructure and the like, in all materials, and use for backfill or embankment or dispose

Replace the words "in 1 m increments" *at the end of the first sentence of Subclause (a) with* "in the increments indicated in the Schedule of Quantities".

Replace "in 5.2.2.1 – 5.2.2.3 (inclusive)" *at the end of Subclause (a) with* "in subclauses 5.2.2.1 to 5.2.2.4 (inclusive)".

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In Subclause (b), replace both "1) intermediate excavation" *and the corresponding unit of measure with* "1) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified in terms of Subclause 3.1.2 as intermediate excavation.

Omit "intermediate," *from the second last line of Subclause 8.3.3(b).*

Add the following Sub-Items:

"(c) Hand excavation where ordered by the Employer's Agent..... Unit: m^3
This item shall apply to hand excavation ordered by the Employer's Agent or when the Employer's Agent considers that, owing to circumstances, excavation by mechanical excavators is not practicable. It shall not apply to hand excavation for trimming or finishing an excavation made by mechanical means and shall also not apply to hand excavation for exposing existing services.
The tendered rate shall include full compensation for the additional cost of excavating by means of hand tools.

(d) Soilcrete backfill where directed by the Employer's Agent ..... Unit: m^3

The unit of measurement shall be the cubic metre of soilcrete placed on the Employer's Agent instructions in accordance with Sub-clause 3.5(d) of SANS 1200 DB, measured in place according to the authorised dimensions.

(e) Backfill stabilised with 5% cement where directed by the Employer's Agent .....Unit: m^3

The unit of measurement shall be the cubic metre of backfill material stabilized, measured in place according to the authorised dimensions after compaction, which was stabilized as shown on the drawings or on the Employer's Agent's instructions. The tendered rate shall include full compensation for any work additional to that priced for in Subclauses 8.3.2 and 8.3.3 (as applicable) to stabilize the backfill material with 5% cement and compacting the stabilised material to the required modified AASHTO density (100% unless otherwise stated).

(f) Excavate for restricted foundations, footings and pipe trenches in all materials and dispose of, and backfill with material from commercial sources (clean sand unless otherwise indicated).....Unit: m^3

The unit of measurement shall be the cubic metre of material excavated on Site which is replaced with material from commercial sources, measured in place in accordance with Subclause 8.2. Separate items will be scheduled for separate structures, for importation from different sources and, in the case of pipe trenches, to different depths in the increments indicated in the Schedule of Quantities.

All restricted excavations will be measured by volume. The volume of short pipe trenches will be computed from the minimum base width of the trench (see SANS 1200 DB). The rate shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 in addition to the cost of excavating in all materials and disposing of these materials, for basic selecting, loading, transporting, off-loading at the spoil site, maintaining and finishing the spoil site and for all other incidental costs to excavate and dispose of the material, all in accordance with the specifications.

The tendered rate shall also include for the costs of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or backfilling, watering, compacting, complying with the requirements for tolerances,

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providing for testing, finishing and tidying, and as more fully specified in Subclauses 5.2.2.1 to 5.2.2.4 (inclusive) and 5.2.3. No payment will be made for the removal of overburden or stockpiling at the commercial source.

(g) Excavate for Sewer Conservancy Tanks in all materials and use for backfill or berm or dispose.....Unit: m³

The provisions of item 8.3.3(a) and8.3.3 (d) shall as applicable apply.
The rate shall further cover the cost of preparing the bottom of the excavations as specified in SANS subclause 5.1.1 of SANS 1200LD, as well as for selective stockpiling of excavated material (refer SANS 1200LD 8.3.3(i)).

(h) Excavate unsuitable material from bottom of conservancy tank excavations and replace with selected material complying with subcluase 3.2.4

(i) Using material from sewer conservancy tank excavations.....Unit: m³
(ii) Using Material from other excavations on site.....Unit: m³
(iii) Using Material from commercial sources.....Unit: m³

(i) Backfill Sewer Conservancy Tank using selected material complying with subclause 3.2.4

(i) Material from other excavations on site.....Unit: m³
(ii) Material from commercial sources.....Unit: m³

The quantity measured for payment shall be the volume of the tank excavations calculated from the nett outline of a tank plus 1000mm side allowance along its entire perimeter and depth of excavation, less the total outside volume of the tank itself.

The rate tendered shall cover the cost of acquiring the material, loading, haulage (in the case of (ii) above irrespective of distance), offloading, placing, watering and compacting the backfill, as well as for additional material required due to any over excavation. (Backfill of a tank using selected material generated by its excavation shall be deemed to be covered by item 8.3.3(c))."

(j) Extra-over to Item 8.3.3(a) to screen fill material to comply with Sub-clause 3.2.3 (as amended)

(i) Material containing more than 10% but less than 20% stones and hard fragments.....Unit: m³
(ii) Material containing more than 20% but less than 30% stones and hard fragments .....Unit: m³

The unit of measurements shall be the cubic metre of fill material screened, measured in place according to the authorised dimensions after compaction. The extra-over tendered rate shall include full compensation for selecting, keeping selected material separate, screening of material to remove particles larger than 50mm, temporary stockpiling, loading, transportation within freehaul distance, offloading and disposal of spoil.

8.2.4 Importing of materials (Subclause 8.3.4)

Replace the heading of 8.3.4(a) with the following heading, without changing the unit of measure:

"Importation of additional material from commercial sources or from borrow pits and use for fill"

Replace the content of 8.3.4(a) with the following:

"Importation of material used for fill will only be the measure of imported material which does not replace excavated material and thus cannot be measured under Subclause 8.3.2(c) or 8.3.3(f). Imported material

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which replaces disposed of excavated material will not be paid for separately under this Subclause but shall be included for in the rates provided under Subclause 8.3.2(c) and 8.3.3(f).

The unit of measurement shall be the cubic metre of material imported, measured in place once compacted in accordance with Subclause 8.2. Separate items will be scheduled for different parts of the Works and for importation from different sources.

The tendered rate for importation of material for fill as described in this Subclause shall cover the cost of complying with any relevant precautions of Subclause 5.1 in addition to the cost of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or filling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications. No payment will be made for the removal of overburden or stockpiling at the commercial source."

8.2.5 Extra excavation in all materials to provide working space around structure (Subclause 8.3.5)

Delete Subclause 8.3.5.

8.2.6 Overhaul (Subclause 8.3.6)

Delete this Subclause and replace with the following:

"Notwithstanding any clauses in any Standardized Specification or Standard Specification Section dealing with the definition, measurement and/or payment for transport, freehaul and/or overhaul, no measurement nor payment for overhaul will be made. All haulage will be considered to be freehaul and the cost therefore will be deemed to be covered by the rates for the provision or disposal of the applicable material."

8.2.7 Existing services (Subclause 8.3.8)

8.2.7.1 Location (Subclause 8.3.8.1)

Replace the contents of this Subclause with the following:

"Hand excavation for locating and exposing existing services:

(a) In roadways ..... Unit: m^3

(b) In all other areas ..... Unit: m^3

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised or actual dimensions of the excavation, whichever is the lesser.

The tendered rates shall cover the cost of excavating in all materials by means of hand tools within authorised dimensions and at locations approved by the Engineer in accordance with the requirements of Subclause 5.4.1 of SANS 1200 A for all precautionary measures necessary to protect the services from damage during excavation and backfilling, and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 90% of the modified AASHTO density.

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The tendered rate for hand excavation in roadways shall include compensation for compacting excavated or selected backfill material to 93% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for in terms of SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water, for removing surplus excavated material from the site, for transporting all material within the free-haul distance, and for supplying adequate supervision during both excavation and backfilling operations. Overhaul, if applicable, will be measured and paid for in terms of SANS 1200 DB."

8.2.8 Topsoiling (Subclause 8.3.10)

Change the unit to "m³" and replace the contents of this Subclause with the following:

"The unit of measurement shall be the cubic metre and the quantity shall be calculated from the authorised dimensions.

The tendered rate shall include loading of the topsoil from stockpiles, transporting it for the free-haul distance, and off-loading, spreading, shaping and lightly compacting the topsoil."

8.2.9 Road traffic signs and markings (Subclause 8.3.12)

Replace the word "Separate" *in the first sentence of Item 8.3.12 with the following:*

"Where the Employer's Agent requires the provision of road traffic signs and/or road markings and/or any other measures additional to those to be provided by the Contractor in accordance with 5.1.6, separate".

Add the following items in Subclause 8.3:

8.2.10 Extra over items 8.3.2(a) and 8.3.3(a) for temporary stockpiling (New Subclause 8.3.14) ..... Unit: m³

The unit of measurement shall be the cubic metre of material from necessary excavations, temporarily stockpiled by the Contractor on the instructions of the Employer's Agent, before being used in embankments or backfill. Measurements shall be taken in place in compacted embankment or backfill as the case may be.

The tendered rate shall include for the costs, additional to those provided for in 8.3.2(a) and 8.3.3(a) of off-loading, forming and maintaining the stockpile for as long as is required, reloading and transporting.

Payments to the Contractor under this item will only be made in respect of that material stockpiled on the instructions of the Employer's Agent (which instruction shall state specifically that payments for such stockpiling will be paid for under this item) and no payments will be made to the Contractor under this item in respect of materials stockpiled by the Contractor on his own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by him in the course of executing the works, whether such stockpiling was avoidable or otherwise.

8.2.11 Trim and compact internal pond wall and floor surface areas to 90% modified AASHTO maximum density (New Subclause 8.3.15)..... Unit : m²

The rate tendered shall cover the cost of providing all labour, plant and equipment to trim and compact the surfaces of the internal wall faces and floor areas to leave a smooth surface, free of all sharp projections and

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localised depressions all in accordance with the tolerances specified, as well as the cost of providing soil to fill depressions and watering of the surface as required.

8.2.12 Survey and protection of surrounding structures before blasting (New Subclause 8.3.16)

The rates shall cover the cost of examining and measuring up any buildings, houses or structures that encroach within the working area or pipeline servitude and establishing and recording, together with the owners thereof, the general condition and/or damage that may exist before commencement of blasting operations, including the cost of providing a photographic record, the costs of reduced working width, and the costs of any special working methods required to protect the structure throughout the course of the nearby construction work.

This shall include, where required, but is not necessarily limited to, the use of shoring or lateral trench support and the placing of barriers to demarcate restricted working area in the vicinity of the structure."

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[redacted]

9 DRAWINGS

9.1 CLASSES OF EXCAVATION (FIGURE D-1)

Replace Figure D-1 with the following figure:

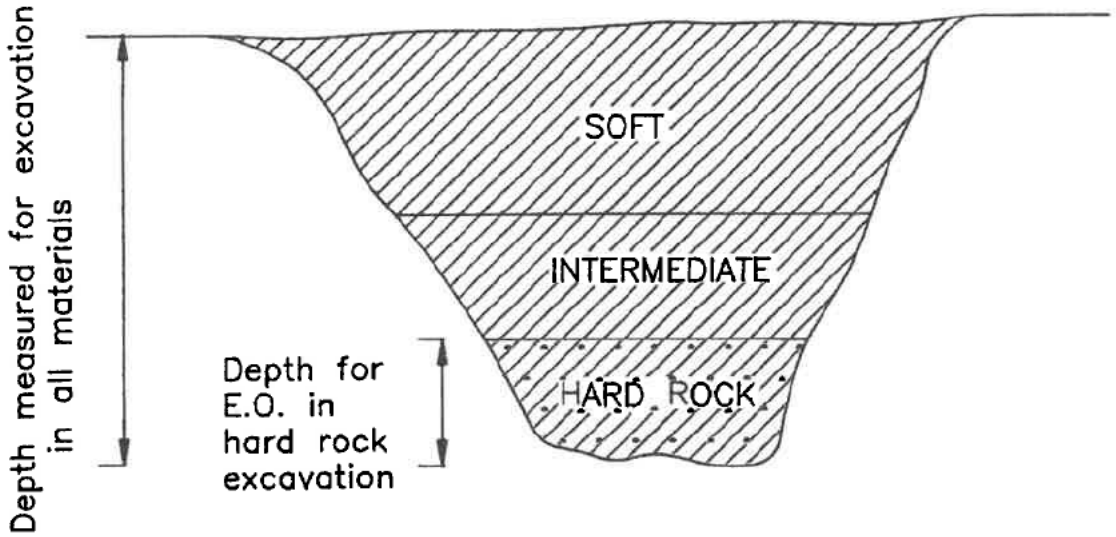


Fig. D–1 – Classes of Excavation: Measurement and Payment

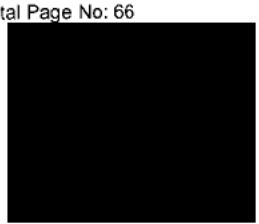
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9.2 CLASSES OF EXCAVATION (FIGURE DB-5) 14

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

3.1 BACKFILL MATERIAL (SUBCLAUSE 3.5)

In the third line of 3.5(a), delete "150mm" *and substitute* "100mm".

In the second line of 3.5(b), delete "P.I not exceeding 12" *and substitute* "P.I not exceeding 6".

Add the following to the end of Subclause 3.5:

"c) Where shown on the drawings or as directed by the Employers Agent, backfill shall be stabilised with 5% cement by mass. The backfill material shall have a plasticity index not exceeding 6 and all material must pass through a sieve of aperture size not exceeding that specified in Subclause 3.2 of SANS 1200 LB.

The soil shall be mixed with 5% cement and shall be compacted in layers of 100 mm thick to 90% of modified AASHTO density.

d) The aggregate for soilcrete shall be mixed with 5% cement and shall consist of approved soil or gravel containing stones not bigger than 19 mm and with a plasticity index not exceeding 10.

The soil or gravel shall be mixed in a concrete mixer with the cement and enough water to acquire a consistency that allows the mixture to be placed with vibrators to fill all voids between the pipe and the sides of the trench. Shuttering shall be used where necessary."

3.2 MATERIALS FOR REINSTATEMENT OF ROADS AND PAVED AREAS (SUBCLAUSE 3.6)

Add the following to the start of this Subclause:

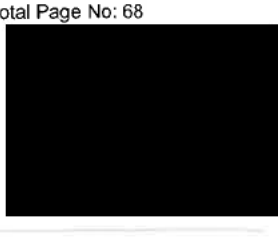
"The materials used in the reinstatement of existing road layers shall comply with the following properties, unless otherwise shown on the Drawings.

a)	Subbase:	PI maximum 10. CBR at least 45% at 95% of MAMDD.
b)	Base:	PI maximum 6. CBR at least 80% at 98% of MAMDD.
c)	Surfacing:	Asphalt surfacing as specified in 3.6.4.
d)	Gravel wearing course:	PI maximum 14 but not less than 10. The size of the aggregate shall not exceed 40 mm. CBR at least 45% at 95% of MAMDD."

3.3 SELECTION (SUBCLAUSE 3.7)

Replace the words "if he so wishes" *in the first line of the second paragraph with the words* "at his own cost".

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4 PLANT (CLAUSE 4)

4.1 EXCAVATION EQUIPMENT (SUBCLAUSE 4.1)

In the first line delete "The Contractor" *and substitute:* "In sections deemed to be excavated by mechanical means, the Contractor".

Add to the end of the Subclause:

"Should any portion of a pipe trench exceed the specified depth, the Contractor will be held responsible for any additional costs which may arise as a result of such over-excavation. Concrete filling or imported compacted fill may be ordered by the Employers Agent to make good any over-excavation."

Add the following new Subclause:

4.2 RESTRICTION ON USE OF PLANT (NEW SUBCLAUSE 4.4)

Where the Contractor finds it impractical to use mechanical plant for excavation or to complete portions of the work due to restrictions caused by difficult access or the presence of existing structures, pipelines or services shown on tender drawings, the Contractor will be deemed to have satisfied himself as to the alternative requirements when entering rates against the appropriate items in the Bill of Quantities as no claim for extra payment based on the inability to use plant in such circumstances will be considered.

5 CONSTRUCTION (CLAUSE 5)

5.1 PRECAUTIONS (SUBCLAUSE 5.1)

5.1.1 Stormwater, seepage and dewatering of excavations (Subclause 5.1.2)

5.1.1.1 Throughout the Works (Subclause 5.1.2.1)

Add the following to the end this Subclause:

"The provisions of this subclause shall apply to all trench and valve chamber excavations. Sections of pipelines and valve chambers will be laid below the water table and ground water will be encountered during excavation. The Contractor shall dewater the excavations to such an extent as to draw the water table down to at least 100 mm below the top of the crushed stone layer, or bottom of the blinding layer, and keep it there until the backfill is complete."

5.1.1.2 Special water hazards (Subclause 5.1.2.2)

Add the following to the end this Subclause:

"The Employers Agent may direct the Contractor to implement subsoil drainage measures at certain sections of the pipe trench where ground water seepage is considered significant. Such drainage measures shall consist of a free draining granular material placed underneath or alongside the pipe, or in separate drainage trenches."

5.1.1.3 Sloping ground (Subclause 5.1.2.3)

Delete the subclause and substitute with the following:

"The Contractor shall be responsible throughout the duration of the Contract, inclusive of the Defects Liability Period, for the provision of all soil erosion preventative measures necessary to protect the trenches, pipeline(s) and land utilized by the Contractor during the Contract from any adverse effects of soil erosion, settlement, scour, etc., resulting from the construction of the Works.

Protection measures for sloping ground shall be implemented in accordance with the percentage grade of the natural existing slope or artificial slope created as shown on the Drawings including the minimum dimensions and maximum spacings of the applicable protection.

Payment will be made for the construction of sloping ground protections provided construction thereof has been either ordered or approved by the Employers Agent prior to the commencement of such construction."

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5.1.2 Accommodation of traffic and access to properties (Subclause 5.1.3)

Replace the semicolon and the word "and" *at the end of Subclause 5.1.3(a)(4)(ii) with a full stop.*

Replace Subclause 5.1.3(b) with the following:

"(b) The Contractor shall provide and maintain pedestrian and vehicular access to properties affected by the works. The Contractor shall construct and maintain to the satisfaction of the Employers Agent, such temporary access roads around, and/or steel or timber bridges over excavations in roads, pavements, entrances or accesses to properties.

Temporary pedestrian access bridges shall be at least 1,2 m wide and temporary access bridges for vehicles shall be at least 3,6 m wide. All temporary access bridges shall be fitted with handrails as well as protective mesh fencing on both sides.

On completion of the work, the Contractor shall dismantle and remove all such temporary constructions and reinstate these areas to their former condition.

Except only where the Employers Agent has included in the Schedule of Quantities, particular payment items specifically therefor, the Contractor will not be paid directly for the construction and maintenance of temporary access roads and/or the provision and maintenance of bridges as aforementioned, and the costs thereof shall be deemed included in the Contractor's tendered rates for excavation."

5.1.3 Existing services that intersect or adjoin trenches (Subclause 5.1.4)

Delete the Subclause and replace with the following:

"The requirements of Subclause 5.1.2 of SANS 1200 D shall apply."

5.1.4 Stability of Trench Excavations (New Subclause 5.1.5)

The precautions for excavations as specified in Clause 5.1.1 of Section 1200 D and 1200 DA shall also apply to all trench excavations.

The Contractor shall take all the steps necessary to ensure that no person is required or allowed to work in a trench or any other unsupported overhanging excavation which is more than 1,5m deep, and any excavation which has not been adequately supported, shored or braced if there is any danger whatsoever of the sides of the excavation collapsing. The support, shoring or bracing to be designed and constructed by the Contractor, shall be strong and sturdy enough to support the sides of the excavation in question.

5.1.5 Removal of existing pipelines (New Subclause 5.1.6)

Where existing pipes have to be removed, an excavation shall be carefully opened by machine down to 300 mm above the pipes after which the whole pipe shall be fully exposed by means of hand excavation. The excavation width shall comply with Subclause 8.2.3.

The pipes shall be removed from the trench in a manner approved by the Employers Agent and brought to the surface for inspection by the Employers Agent.

Pipes that are declared suitable for reuse and pipes declared unfit for reuse shall be dealt with in an applicable manner described in the specifications, or on the Drawings or on the Employers Agent's instructions, as relevant.

5.1.6 Working areas (New Subclause 5.1.7)

The construction of the Works shall be restricted to the "working areas" indicated on the drawings. The Contractor requires written permission from the Employers Agent should he wish to work outside the specified "working areas".

5.2 MINIMUM BASE WIDTHS (SUBCLAUSE 5.2)

For Subclause 5.2, delete all instances of the word "External" *and replace with* "Nominal."

Delete Subclause 5.2(b) and substitute the following:

"b) The base width for unbedded flexible continuous piping of nominal diameter not exceeding 125mm laid at a depth not exceeding 1,5m, shall be equal to the nominal diameter of the pipe, plus a side allowance of 200mm on either side.

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c) Should any ducts or services be placed in the same trench as a pipe, there shall be a minimum clear space of 300 mm between the pipework and the ducts/services, unless otherwise specified or shown on drawings."

5.3 EXCAVATION (SUBCLAUSE 5.4)

Add to the Subclause:

"All pipelines shall be laid to the invert levels and gradients shown on the drawings. Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 1250 mm (as measured from the original ground level to the top of the pipe barrel).

All excavated material shall be kept within the working area and designated sites as indicated on the drawings and shall be so deposited as not to interfere with or endanger the Works (for example, by causing the sides of the excavation to collapse), other property, or traffic.

The toe of the stockpile shall be trimmed well back from the edge of the trench so as to leave a minimum 1,5 m clearance between the edge of the stockpile and the edge of the trench. The Contractor shall keep this strip clear of excavated material at all times and take all necessary steps to prevent mixing with material set aside for backfill.

The Employers Agent may, in terms of Subclauses 5.6.3 and 5.6.4, order the Contractor to remove any material which he considers liable to endanger or interfere with the Works, private property, traffic, or pedestrians, and to place such material at some other approved position. If the necessity for such removal is, in the opinion of the Employers Agent, a result of some default on the part of the Contractor, the cost thereof shall be borne by the Contractor, otherwise the cost will be borne by the Employer at a sum pre-agreed with the Employers Agent or measured as Daywork, whichever is the more appropriate in the opinion of the Employers Agent.

The maximum allowable length of open trench with no pipe shall not exceed 200m on any single construction front. The total length of open trench on any single construction front shall not exceed 300m and on all construction fronts shall not exceed 600m (without approval of the Employers Agent).

For the sections with high water tables, the Contractor shall dewater the ground, excavate and support the trench and lay, bed and backfill the pipe up to the original ground level, including removal of the trench support and stopping dewatering. A detailed method statement covering the complete operation shall be submitted to the Employers Agent for approval.

The Contractor shall complete all backfilling, trimming, levelling and cleaning up of the Site as work proceeds.

Unless otherwise ordered or approved by the Employers Agent, furrows and subsurface drainage shall be reinstated to match dimensions and standards they were before being disturbed by the Contractor's activities. The work shall be carried out as soon as the pipeline (or appurtenant works) has been laid, tested and backfilled."

5.4 TRENCH BOTTOM (SUBCLAUSE 5.5)

In the subclause, replace "100 mm below" *to read* "200 mm below".

Delete the second last sentence starting with 'Where the bottom of the trench has been loosened……' *and replace with* "The bottom of the trench shall be compacted at OMC to 90% of modified AASHTO maximum density prior to bedding and pipelaying."

Add the following new subclauses to Subclause 5.5:

5.4.1 Jointing Holes (New Subclause 5.5.1)

Jointing holes shall be cut of sufficient length and depth to allow for the proper making or bolting of pipe joints and to ensure that joint collars or sleeves do not rest on the trench bottoms. After the pipework has been inspected, tested and approved by the Employers Agent, the jointing holes shall be refilled with selected soft material free from stone (bedding materials as specified) and then rammed to provide a continuous uniform support for the pipework.

No specific payment will be made for forming and refilling holes, the cost of which is deemed to be included in the tendered rates.

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[redacted]

5.4.2 Unstable trench bottom (New Subclause 5.5.2)

The Employers Agent may, upon consideration of the condition of the trench bottom, particularly with regard to the properties of the soil materials, order the use of a crushed stone layer in order to provide a stable platform for placing of the pipe bedding and laying the pipe in certain sections of the trenches.

The stone layer detail shall be in accordance with the Drawings.

If no detail is available, the stone layer shall consist of 19 mm single-sized crushed stone and shall have a minimum specified thickness of 300 mm over the specified minimum base width. The stone layer shall be completely wrapped within a geotextile filter blanket which shall comply with the requirements of SANS 1200 DK, and shall have overlaps of at least 300 mm.

5.5 BACKFILLING (SUBCLAUSE 5.6)

5.5.1 General (Subclause 5.6.1)

Add to the Subclause:

"Notwithstanding the requirements of this Subclause and Subclause 5.6.6, no pipe joint nor pipe fitting shall be covered by either blanket or backfill material prior to the successful completion of the visual inspection and pressure testing of the relevant section of the pipeline."

5.5.2 Material for Backfilling (Subclause 5.6.2)

Delete the second paragraph and substitute the following:

"Hard rock material shall not be used for, or incorporated into, the backfill above the bedding layers without the Employers Agent's approval."

Add the following to the end of this Subclause:

"The final 150mm of the trench shall be backfilled with topsoil which was previously stockpiled. Care must be taken to ensure that the trench is slightly overfilled so that it does not become a rivulet in wet weather."

5.5.3 Disposal of Soft Excavation Material (Subclause 5.6.3)

Delete the contents of this Subclause and add the following:

"Except where, in the opinion of the Employers Agent, the excavated material is unsuitable for disposal in one or the other of the following methods, surplus material of suitable quality and containing particles less than 50mm in size, may be spread evenly over the area cleared and grubbed provided it does not raise the original ground level by more than a maximum height of 100mm, or it may be disposed of at disposal areas/sites identified by the Contractor and approved by the Employer's Agent. The Contractor shall make the necessary arrangements with the owner of the site where the material is disposed of and pay all charges and levies as may be applicable for the use of such spoil sites.

Material disposed of in approved disposal areas shall be spread in such a manner that it will not cause water to dam up, and shall be levelled, trimmed and lightly compacted to neat lines and levels."

5.5.4 Disposal of Intermediate and Hard Rock Material (Subclause 5.6.4)

After the words "the surplus shall", *insert the following* ", as directed by the Employers Agent,".

5.5.5 Transport for Earthworks for Trenches (Subclause 5.6.8)

Delete the contents of this Subclause and substitute the following:

"The requirements of Subclause 5.2.5 of SANS 1200 D shall apply."

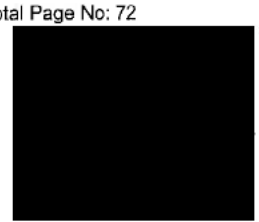
Add the following subclause:

5.5.6 Backfilling around structures (New Subclause 5.6.9)

Backfilling around a structure shall not be commenced before it has been approved by the Employers Agent.

Granular material shall be used as backfill material around structures as shown on the drawings and shall be placed in layers not exceeding 150 mm compacted thickness, each layer being thoroughly compacted to

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100% of modified AASHTO density as instructed by the Employers Agent before the succeeding layer is placed. Unsuitable or surplus excavated material shall be spoiled off site.

5.6 COMPACTION (SUBCLAUSE 5.7)

5.6.1 Areas not Subject to Traffic Loads (Subclause 5.7.1)

Add to the end of this Subclause:

"All non-cohesive material shall be compacted to 100% MOD AASHTO density."

5.6.2 Areas Subject to Traffic Loads (Subclause 5.7.2)

Delete "98%" *and substitute with* "100%".

Add the following to the end of this Subclause:

"All pipe trenches that fall within the road reserves shall be regarded as areas subject to traffic loads. Where no road reserve is registered, a 3m offset from the outer edge of the road will be regarded as an area subject to traffic loads. This condition shall apply to both formal and informal (farm) roads."

5.7 REINSTATEMENT OF SURFACES (SUBCLAUSE 5.9)

5.7.1 Width to be Reinstated (Subclause 5.9.1)

Replace Subclause 5.9.1.1 with the following:

"The reinstatement of surfaces over the full extent of the top of the actual excavation shall comply with the applicable requirements given in Subclause 5.9.2-5.9.5 (inclusive), unless otherwise shown on the Drawings."

5.7.2 Bitumen Roads: Sub-Base and Base (Subclause 5.9.4)

Add to the Subclause:

"The rates shall include for the costs of reinstating all surfaces and inclusive of all layers to their original condition before the commencement of construction."

5.7.3 Bitumen Roads: Surfacing (Subclause 5.9.5)

5.7.3.1 General (Subclause 5.9.5.1)

Add to the Subclause:

"The rates shall cover the costs of reinstating all surfaces, kerbing and drainage channels to their original condition before the commencement of construction."

Add the following new subclause:

5.8 TRENCH WALL STABILITY (NEW SUBCLAUSE 5.11)

Notwithstanding the requirements of Subclause 5.4 above, the Contractor shall take responsibility for the length of trench open at any time and if collapse of the side walls occurs for any reason, the responsibility will be the Contractor's and he will reinstate and make good at his own cost.

6 TOLERANCES (CLAUSE 6)

No amendments.

7 TESTING (CLAUSE 7)

Replace the contents of Subclause 7.1 with the following:

"The Contractor shall carry out density tests as specified in TMH1: Standard Methods of Testing Road Construction Materials, 1986, in the positions indicated by the Employers Agent, to determine the compaction

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of the backfill material in the trenches and the material used for reinstating the road construction layers. No single test result which is below the specified density, will be accepted.

In the case of trenches in areas subject to traffic loads, the Contractor shall bear the cost of all density tests carried out except in the following case. Where the test results in areas subject to traffic loads are equal to or exceed the specified density, the Employer will bear the cost of that number of those tests ordered by the Employers Agent in excess of two tests per layer of the bedding, backfill and reinstated road layers.

In the case of trenches not in areas subject to traffic loads, the Contractor shall undertake two density tests per 20 m of installed pipe, one test on each side of the pipe, per layer backfilled (bedding and backfill). The Contractor shall bear the cost of these density tests. The Contractor shall also bear the cost of additional density tests ordered by the Employers Agent where the test results of these additional tests are below the specified density.

If the density is found, in any case, to be below the specified value, the Employers Agent may order the re-compaction of the backfill and retesting, both at the Contractor's expense."

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

In Subclause 8.1.1, delete the words "along the route of the pipeline"

At the end of Subclause 8.8.2 (b), remove the full stop and add the following: ", or in such graduations as scheduled".

In Subclause 8.1.2(c), amend the last sentence to read:

"The ground surface will be that existing after any bulk excavation has been carried out and before any embankment has been constructed, unless a portion of the embankment has to be constructed in order to achieve an acceptable cover over a pipe that is to be installed, in which case, measurement will be made from the level of embankment that produces an acceptable minimum cover over the pipe."

Add the following to the end of Subclause 8.1.3:

"No additional payment will be made for excavating and backfilling of jointing (fox) holes as the cost of that work will be deemed to be included in the rates for trenching."

8.2 COMPUTATION OF QUANTITIES (SUBCLAUSE 8.2)

Replace the contents of Subclause 8.2.3 with the following:

"Wherever volumetric measurement is required, the volume will be computed according to the depths indicated on the drawings, or to the bottom of the specified bedding cradle, whichever is the greater, and the minimum width determined from the applicable side allowance set out in 5.2 (see drawing DB-4 also) plus the nominal width of the pipe. No allowance shall be made for the extra thickness of the collars or couplings."

8.3 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.3.1 Site clearance and (if specified) removal of topsoil (Subclause 8.3.1)

In Subclause 8.3.1(c), replace the words "(depth stated)" *with the words* "to a minimum depth of 150mm".

Add the following to the end of 8.3.1(c)

"The topsoil stockpile material shall be stabilized by watering or other approved means."

8.3.2 Excavation (Subclause 8.3.2)

Replace the words "increments of 1,0 m" *in the first sentence of 8.3.2(a) with* "increments as specified in the Schedule of Quantities".

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In Subclause 8.3.2(b), replace both "1) intermediate excavation" *and the corresponding unit of measure with* "1) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

Omit the phrase "intermediate or" *from the first paragraph of Subclause 8.3.2(b).*

Add the following to the end of Subclause 8.3.2(b):

"No payments will be made under 8.3.2(b)(1) and 8.3.2(b)(2) in respect of any materials measured and paid for under 8.3.2(b)(3) below.

3) Hand excavation and backfill by hand where ordered by the Employers Agent

a) Soft and intermediate material ..... Unit : m^3

b) Hard rock material ..... Unit : m^3

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, which was excavated by hand on the specific prior written instructions of the Employers Agent; provided always that the Employers Agent's said instruction shall have stated that measurement and payment for such hand excavation will be in accordance with this item.

The tendered rate shall include full compensation for the additional cost, effort and time resulting from excavating in the respective materials using hand methods only.

The Employers Agent shall not be obliged to authorise payment under this item in respect of any hand excavation carried out (whether ordered in writing or otherwise), which hand excavation was in any case necessary to achieve compliance by the Contractor with his obligations under the Contract to:

i) utilise construction appropriate to the nature of the specific parts of the works; and/or

ii) protect existing structures and/or services; and/or

iii) comply with all prevailing legislation and regulations.

4) Stabilizing backfill with 5% cement where directed by the Employers Agent ..... Unit : m^3

The unit of measurement shall be an extra over to the backfilling measured elsewhere (i.e. 8.3.2(a)), measured as the cubic metre of backfill material that is stabilized, measured in place after compaction according to the authorised dimensions, which was stabilized on the Employers Agent's instructions in accordance with subclause 3.5(c).

The tendered rate shall include full compensation for stabilizing backfill material as specified in subclause 3.5(c), including but not limited to supplying cement, selecting and mixing the material.

5) Working within a restricted working area ..... Unit : m

Extra-over payment will be scheduled for working in restricted working areas of the following width categories, as indicated on the Drawings:

a) 5 – 10 m

b) 10 – 15 m

c) 15 – 27 m

The extra-over rates shall cover the costs associated with the method of excavation employed, including all bracing, shoring, battering and the like required to ensure safe trench and working conditions, as well as any extra costs involved in double handling, temporary stockpiling and transportation of backfilling, compacting and disposing of surplus material. The rates shall also include the costs associated with the handling, jointing and installation of the pipelines within a restricted works area.For pipelines with a nominal diameter larger than 500 mm, working widths in excess of 27 m will be regarded as unrestricted and no extra-over payment

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will apply. For nominal pipeline diameters of 500 mm or less, a working width more than 15 m will be considered unrestricted and no extra-over payment will apply.

The extra-over rates shall be applicable to all depth categories as indicated on the Drawings.

No payment shall be made under this clause for restricted working areas that occur as a result of the Contractor's other activities on site. The Contractor shall sequence the works to ensure sufficient working space is available for all activities."

6) Disposing of spoil material on a site provided by the Contractor.....Unit: m^3

No extra-over payment shall be made for disposing of spoil material on sites provided by the Contractor. The cost of disposing of spoil material shall be included in the rates tendered to 'excavate in all materials for trenches, backfill, compact and dispose of surplus material'. All haul will be regarded as free haul as per Subclause 8.3.6 of SANS 1200 D.

7) Soilcrete backfill where directed by the Employer's Agent.....Unit : m^3

The unit of measurement shall be the cubic metre of soilcrete placed on the Employer's Agents instructions in accordance with subclause 3.5(d), measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required.

Add the following after Subclause 8.3.2(c):

"d) Excavate in all materials for stormwater inlet and outlet structures and for manholes, culverts, catchpits, valve chambers and the like, irrespective of depth, and backfill around these structures: ..... Unit : m^3

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised dimensions, and excluding the volume of material excavated and paid for under subitem (a).

The tendered rate shall include for the costs of excavating in all materials, backfilling, compacting, trimming and tidying the final surface around the structure, disposing of surplus and unsuitable materials within the free-haul distance and, where applicable, selecting and keeping separate, excavated material suitable for use as backfill.

e) Excavate open drains in all materials: ..... Unit : m^3

The tendered rates shall include full compensation for excavating in all materials within the dimensions specified or authorised by the Employer's Agent and to the specified lines and profiles, for the disposal of surplus and unsuitable excavated material where applicable, and in the case of item (d), for backfilling with suitable approved material compacted to 90% of modified AASHTO density around the structures.

f) Extra over items 8.3.2 (d) and (e) for excavating in:

1) Hard rock material ..... Unit : m^3

Measurement and payment shall be in accordance with the provisions of Subclause 8.3.2(b) of SANS 1200 D."

8.3.3 Excavation Ancillaries (Subclause 8.3.3)

8.3.3.1 Compaction in road reserves (Subclause 8.3.3.3)

Replace the sentence "The volume will be measured as specified in 8.2.2, 8.2.3 and 8.3.3.1" with the following:

"In the case of gravel roads, determining the volume, the depth will be measured from the underside of the gravel wearing course to the top of the fill blanket, and in the case of bitumen roads, from the underside of the subbase to the top of the fill blanket.

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[redacted]

The rest of the trench shall be backfilled as specified in subclauses 5.9.3, 5.9.4 and 5.9.5, as applicable, and payment will be made under item 8.3.6.1."

8.3.3.2 Overhaul (Subclause 8.3.3.4)

Delete the contents of this Subclause and replace with the following:

"All haul will be regarded as free haul as per Subclause 8.3.6 of SANS 1200 D."

8.3.4 Particular Items (Subclause 8.3.4)

Replace the heading and contents of Subclause 8.3.4(a) with the following:

"a) Shoring. Payment for shoring of trenches **required due to restricted working widths** shall be covered under the rates tendered for items specified in subclause 8.3.2(b) 5 above. Shoring of other excavations shall be dealt with under this payment item."

Shoring measured under this item will be provisional and only apply when ordered by the Employer's Agent.

The rate shall cover the cost of supply, placing, maintenance and removal of timbering and other support measures together with any cost that results from the inconvenience of working in the supported excavation, the cost of any risks inherent in the operation and the surrounding geotechnical conditions.

8.3.5 Existing Services that Intersect or Adjoin a Pipe Trench (Subclause 8.3.5)

At *the end of the Subclause* 8.3.5(b), replace the full stop with a semi colon and add the following:

"v) all work involved in locating the service by hand excavation;

vi) notifying and attending upon the proprietor of the service;

vii) supporting and protecting the service while the pipeline is installed, inspected, tested and backfilled.

viii) Adhering to all Health and Safety or service provider specific requirements while working in the proximity of the service."

8.3.6 Finishing (Subclause 8.3.6)

8.3.6.1 Reinstate road surfaces complete with all courses (Subclause 8.3.6.1)

*Before the words "*and subsequently of reinstatement*" in the final paragraph, insert the following:*

"importation of material from commercial sources if required by the Employer's Agent to restore each road course to its original state or better, "

Add the following to the end of this Subclause:

"Where the trench crosses asphalt road surfaces, the rate shall include for neatly sawcutting the existing asphalt surfacing."

8.3.6.2 Reinstate other items (New Subclause 8.3.6.2)

Other items to be reinstated and their unit of measure shall be as scheduled. The rate shall cover all relevant costs described in subclause 8.3.6.1 and any further costs associated with and necessary to complete the work scheduled.

8.3.7 Temporary stockpiling of wet material from trench excavations (New Subclause 8.3.8)

The excavation and stockpiling of material which is too wet to be placed in a stockpile, will be measured by the volume, based on the specified trench width, depth and length, which the Employer's Agent orders to be removed.

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The rate shall cover the cost of all operations required to handle, transport to a suitable site and spread to allow the material to dry sufficiently, as well as any costs for disruptions, delays and associated overhead costs resulting from drying out the material.

Should the material which is replaced in the trench become too wet again to achieve necessary compaction, due to the fact that the Contractor made insufficient provision for the handling and removal of groundwater in accordance with Subclause 5.5 of SANS 1200 A, the Contractor shall replace the material at his own cost with material which is, in the opinion of the Employer's Agent, suitable.

8.3.8 Reinstatement of existing stormwater infrastructure (New Subclause 8.3.9)

The reinstatement of furrows and subsurface drainage will be measured separately by length.

Sections of the furrows and canals which are measured in accordance with subclause 8.3.5 will not be measured under this item.

The rates shall cover the cost of reconstructing the furrows and subsurface drainage to the dimensions and standards of the existing, including the provision of all plant, labour and materials required to complete the work.

8.3.9 Stone bedding layer and geotextile filter blanket (New Subclause 8.3.10)

Where the use of a layer of stone in the trench bottom has been authorised by the Employers Agent, it will be measured by volume calculated according to the length multiplied by the specified thickness and specified minimum base width.

The rate shall exclude the cost of all additional excavation and preparation of the trench bottom to accommodate the layer of stone, the removal of unsuitable material, but cover the supply and placing of a layer of stone at least the specified thickness over at least the specified width and all related activities in order to produce a stable platform.

The geotextile filter blanket shall cover each stone layer as specified and shall be measured by area as:

Area = 2 x (specified thickness + minimum base width) x net length.

The rate shall include the cost of supply, placing and losses as a result of overlaps and over excavated trench widths.

8.3.10 Survey and protection of surrounding structures before blasting (New Subclause 8.3.11)

The rates shall cover the cost of examining and measuring up any buildings, houses or structures that encroach within the pipeline servitude and establishing and recording, together with the owners thereof, the general condition and/or damage that may exist before commencement of blasting operations, including the cost of providing a photographic record, the costs of reduced working width, and the costs of any special working methods required to protect the structure throughout the course of the nearby construction work.

This shall include, where required, but is not necessarily limited to, the use of shoring or lateral trench support and the placing of barriers to demarcate restricted working area in the vicinity of the structure.

8.3.11 Cross embankments, cross walls and concrete anchor blocks (New Subclause 8.3.12)

(i) Cross embankments.....Unit: m^3
(ii) Cross walls.....Unit: m^3
(iii) Concrete anchor walls.....Unit: m^3

The rate tendered shall cover the cost of all material, plant and labour, including shuttering and formwork, placing, shaping, compaction required to construct the embankments and walls to the dimensions shown on the drawings.

9 DRAWINGS

9.1 EXCAVATION MEASUREMENT (FIGURE DB-2)

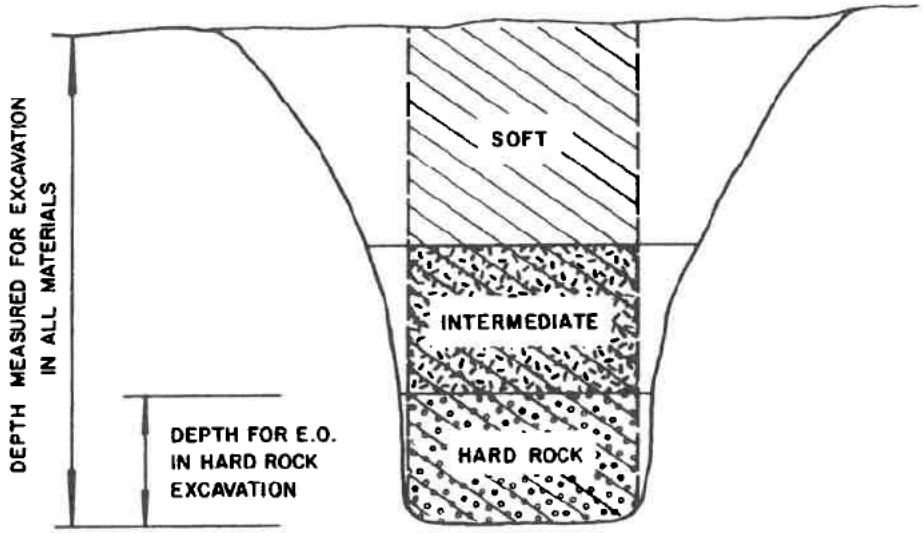
For Note c), replace the phrase "Intermediate excavation and rock excavation are" *with* "Rock excavation is"

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9.2 CLASSES OF EXCAVATION (FIGURE DB-5)

Replace Figure DB-5 with the following figure:



Drawing DB - 5 - Classes of Excavation: : Measurement and Payment

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[redacted]

1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATIONS (CLAUSE 2)

2.1 SUPPORTING SPECIFICATIONS (SUBCLAUSE 2.1)

Replace Subclause 2.1.2 with the following:

"Any of the other SANS 1200 specifications may form part of the Contract documents."

2.2 DEFINITIONS (SUBCLAUSE 2.3)

Add the following definitions:

"Cement Stabilised: A material mixed (while dry) with cement on a % volume of total material ratio. The material is placed and compacted to a density like a normal fill material.

Commercial source: A source of material provided by the Contractor, not the Employer, and including any borrow pit, provided by the Contractor.

Chimney drain: An internal drain comprising cohesionless material falling within a specified grading envelope, placed on the downstream side of the Core or Transition Zones as specified, so that it will intercept seepage flow passing through the core and divert it down to original ground level from where it will be carried in other drains to the downstream toe.

Essential excavation. An excavation required as an integral part of the finished works, including excavations ordered by the Employer's Agent.

Pass. The complete coverage by a compacting roller over every part of a layer of fill with approved overlaps at the sides and ends of each machine run.

Solum. The area on which the embankment is to be placed.

Restricted excavation. Only the excavations in the following list will be deemed to be "Restricted excavation

a) Subsurface gallery

b) Gallery ventilation pipe

MAMDD: Modified AASHTO maximum dry density"

3 MATERIALS (CLAUSE 3)

3.1 CLASSIFICATION FOR EXCAVATION PURPOSES (SUBCLAUSE 3.1)

3.1.1 Method of classifying (Subclause 3.1.1)

Add the following:

"The classification of material other than 'soft excavation' shall be agreed upon before excavation may commence.

The Contractor shall immediately inform the Employer's Agent if and when the nature of the material being excavated changes to such an extent that a new classification is warranted for further excavation. Failure on the part of the Contractor to advise the Employer's Agent in good time shall entitle the Employer's Agent to reclassify, at his discretion, such excavated material."

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3.1.2 Classes of excavation (Subclause 3.1.2)

Replace the first sentence with the following:

"Notwithstanding the excavation of material classifications that follow, the materials excavated, other than hard rock and boulder excavation, will not be classified for the purposes of measurement and payment. The unit rate for excavation shall cover the cost of excavation in all materials with the only extra-over items payable being those for excavation in hard rock and boulder excavation."

3.2 CLASSIFICATION FOR PLACING PURPOSES (SUBCLAUSE 3.2)

3.2.1 Earthfill material (Subclause 3.2.1)

Remove the contents of Subclause 3.2.1 and insert them in 3.2.1.1 General below.

Add the following subclauses: "

3.2.1.1 General (Subclause 3.2.1.1)

Insert the contents of Subclause 3.2.1 as noted above

3.2.1.2 Zone G7* : Selected general fill zone (Subclause 3.2.1.2)

This material is for use as the fill of the reservoir embankment.

In addition to the requirements of Subclause 3.2.1.1 the following shall apply:

The material for this zone is obtained from imported sources. The material available from excavations on site is not suitable for use in the embankment. Grading analyses shall be done to µ2 (TMH1 A1-A6) and a grading envelope in which the Zone G7* material must fall within is shown on Figure No DE-01.

The material shall comply with all requirements for its classification as G7 fill according to SANS 1200 M and test results provided for the approval of the use of the material. In addition grading envelope requirements as indicated above. Furthermore, the material shall comply with the strength parameters as follows, as determined through a suite of shear box or triaxial tests, as relevant to the type of material. Each test result:

- shall have an angle of friction (°) value of 36° or higher
- shall have a cohesion value of 5 kPa or more but not higher than 10 kPa

The material shall have a pH < 9 and pH >3.

The material shall be "non dispersive", as classified through a weighting as indicated in the Table DE-1 below, consisting of combination of testing methods including: Crumb test, Double hydrometer, Sodium absorption ratio, Cation exchange capacity vs. percentage exchangeable sodium, sodium absorption ratio and Pinhole test.

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Table DE-1

Test	Class and weighting	Description of dispersivity			
Pinhole test	Class	Dispersive	Moderate	Slightly	Non-dispersive
	Weighting	5	3	1	0
CEC vs. ESP	Class	Highly	Dispersive	Marginal	Non-dispersive
	Weighting	4	3	1	0
Crumb test	Class	Strong reaction	Moderate	Slight	No reaction
	Weighting	3	2	1	0
SAR	Class	>2	1.5-2.0		<1.5
	Weighting	2	1		0
TDS vs. %Na	Class	Dispersive	Intermediate		Non-dispersive
	Weighting	2	1		0
Total dispersivity rating		**Highly**	**Moderately**	**Slightly**	**Non-dispersive**
		>12	**8-11**	**5-7**	

The test results shall be submitted to the Employer's Agent for approval of the materials proposed by the Contractor, the test results shall also include results of:

- Moisture content (TMH1 A17)
- MAMDD and Optimum moisture content (OMC)
- Unified Soil classification "

3.2.1.3 Zone G6* (Subclause 3.2.1.3)

This material is for use as the pioneer layer underlying various parts of the reservoir embankment and basin floor.

In addition to the requirements of Subclause 3.2.1.1 the following shall apply:

The material for this zone is obtained from imported sources. The material available from excavations on site is not suitable for use in the embankment. Grading analyses shall be done to µ2 (TMH1 A1-A6) and a grading envelope in which the Zone G6* material must fall within is shown on Figure DE-01.

The material shall comply with all requirements for its classification as G6 fill according to SANS 1200 M and test results provided for the approval of the use of the material. In addition grading envelope requirements as indicated above. Furthermore, the material shall comply with the strength parameters as follows, as determined through a suite of shear box or triaxial tests as relevant for the material in question. Each test result:

- shall have an angle of friction (°) value of 40° or higher
- shall have a cohesion value of 3 kPa or more but not higher than 10 kPa

The material shall have a pH < 9 and pH >3.

The material shall be "non dispersive", as classified through a weighting as indicated in the Table DE-1 above, consisting of combination of testing methods including: Crumb test, Double hydrometer, Sodium absorption

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ratio, Cation exchange capacity vs. percentage exchangeable sodium, sodium absorption ratio and Pinhole test.

The test results shall be submitted to the Employer's Agent for approval of the materials proposed by the Contractor, the test results shall also include results of:

- Moisture content (TMH1 A17)
- MAMDD and Optimum moisture content (OMC)
- Unified Soil classification

3.2.1.4 Zone G7std : Selected general fill zone (Subclause 3.2.1.4)

This material is a provisional item as an alternative to Zone G7* (Subclause 3.2.1.2) for use as the bulk fill of the reservoir embankment. This material would replace most, but not all, of the Zone G7* material as an alternative design for the embankment zoning. In this alternative zoning Zone G7std would comprise the bulk of the fill, with an intermediary layer of Zone G7* between Zone G7std and any other fill, except for the downstream face topsoiling.

The requirements for Zone G7std will be identical to that of Zone G7* as specified in Subclause 3.2.1.2, with the exclusion of the grading requirement. "

3.2.2 Filter Materials (Subclause 3.2.2)

Remove the contents of Subclause 3.2.2 and insert them in 3.2.2.1 General below.

Add the following subclauses: "

3.2.2.1 General (Subclause 3.2.2.1)

Insert the contents of Subclause 3.2.2 as noted above.

3.2.2.2 Sand blanket zone (Subclause 3.2.2.2)

The material for this zone is obtained from imported sources. Material for transition/filter sand shall clean cohesionless sand, be non-plastic and shall conform to the gradings indicated in the grading envelope shown on Figure DE-1. The material shall be free draining. The percentage passing the 0.075 mm shall not exceed 3% unless otherwise directed by the Employer's Agent. Depending on the actual grading of the Zone G7* and G6* materials provided by the contractor and approved, the grading of the filter zone may need to be amended during construction as instructed by the Employer's Agent in order to meet the criteria for prevention of piping, segregation and meeting permeability criteria.

The permeability not less than $1x10^{-5}$ m/s, as tested through a constant head test at 95% MAMDD.

The following test results must also be provided in support of the above requirements for approving the use of the material: Organic impurities %, MAMDD, Unified Soil classification."

4 PLANT (CLAUSE 4)

4.1 COMPACTION PLANT (SUBCLAUSE 4.2)

Remove the contents of Subclause 4.2 and insert them in 4.2.1 General below.

Add the following Subclauses:

4.1.1 General (New Subclause 4.2.1)

Insert the contents of Subclause 4.2 as noted above.

Add the following: "Smooth drum rollers shall not be used on the embankment fill zones unless otherwise required by manufacturers specifications for geotextile installation."

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[redacted]

4.1.2 Sheepsfoot rollers (New Subclause 4.2.2)

Sheepsfoot rollers shall be self-propelled or drawn by tractor. The gross mass of the rollers shall be determined on Site to suit the characteristics of the material but shall not be less than 6 000 kg per m length of drum. The mass of the rollers shall be increased by the addition of ballast as required. The outside diameter of the drum shall not be less than 1.5 m and the length not less than 1.2 m or more than 1.8 m. Each roller shall have one or more drums so mounted as to permit turning on a small radius and shall be capable of being propelled in either direction.

The feet of a sheepsfoot roller shall be at least 200 mm overall in length and shall be fitted with hard steel ends (bearing area). The bearing area of each foot shall not be more than 4 000 mm^2 in cross section, with the feet spread out at one per 40 000 to 60 000 mm^2 of drum area. Each drum shall be equipped with cleaner bars so designed and attached as to prevent material packing between the feet. A padfoot roller may be used as an alternative to the sheepsfoot roller with similar specification as relevant with signed approval of the Employer's Agent.

4.1.3 Vibrating rollers (New Subclause 4.2.3)

Vibrating rollers shall have a mass of at least 9 tons on the drum and a variable frequency of vibration in the range 1 000 to 2 000 cycles per minute.

4.1.4 Restricted area compactor (New Subclause 4.2.4)

Restricted area compactors shall be the hand held mechanical compactors of the "whacker" type or similar approved equipment capable of achieving the required densities, and in the case of the in-situ foundation, without leaving a smooth surface."

5 CONSTRUCTION (CLAUSE 5)

5.1 PRECAUTIONS (SUBCLAUSE 5.1)

Add the following Subclause:"

5.1.1 Safeguarding of embedded new infrastructure (New Subclause 5.1.4)

The placing of material around or on top of new infrastructure located within the embankment or the basin should be done with great care not to damage or disturb the infrastructure in question in any way. This includes items such as the outlet pipe, the drainage gallery, the leakage collection pipes, groundwater drainage pipes, monitoring instruments (and their cabling) and the air vent pipe. Cables and pipes shall be placed in backfilled trenches below the top layer of fill, and clearly marked and protected from damage by construction equipment and vehicles.

5.1.2 Safeguarding of Excavations (Subclause 5.1.1)

Replace the contents of Subclause 5.1.1.1 with the following:

"The Contractor's Health and Safety Representative, appointed in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), shall ensure that excavations are suitably safeguarded as required in terms of the said act and its latest regulations."

5.1.3 Explosives (Subclause 5.1.2)

Replace the contents of Subclause 5.1.2 with the following:

"Subclause 5.1.1.3 in SANS 1200 D and its amendments shall apply."

5.2 METHODS AND PROCEDURES (SUBCLAUSE 5.2)

5.2.1 Clearing and Stripping of Site (Subclause 5.2.1)

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5.2.1.1 Conservation of topsoil (Subclause 5.2.1.2)

Replace the contents of this Subclause with the following:

"When so scheduled and when there is suitable topsoil within the limits of the area to be cleared, namely the dam footprint among others, the Contractor shall remove and suitably conserve topsoil for later re-use. The Contractor will not be required to remove topsoil from any area in which the average depth of soil is less than 150 mm."

5.2.2 Excavation (Subclause 5.2.2)

5.2.2.1 Preparation of exposed surfaces (Subclause 5.2.2.2)

In the first line after the word "foundation" *add* "of the core zone or any structures".

Add the following at the end of the Subclause b):

"Prior to placing any embankment material on the solum, all material that has become loosened or over wet shall be removed if so directed by the Employer's Agent.

The surface on which material shall be placed shall be excavated so that the slopes are not steeper than 1V:1H, or as directed by the Employer's Agent or as defined on the drawings. This surface shall be prepared by ensuring that it is cleared of mud, silt and standing water.

Should plant roots or other unsuitable material be found at the founding depth these shall be removed by further excavation.

Where the in situ material has been disturbed by activities such as tree grubbing, yet is approved for use as general fill, the disturbed material shall be removed to such depth as directed by the Employer's Agent and placed and compacted in layers as specified for the fill to be placed over it.

No fill materials shall be placed against or on any portion of the solum of the embankment or basin until the area on which it is to be placed has been compacted to a relative density equivalent to or higher than the embankment zone to be superimposed, and has been inspected, surveyed and approved by the Employer's Agent in writing.

c) Drainage

In the event of sub-surface seepage flows being encountered in the excavation, temporary drains leading to pump sumps shall be provided in the excavation so as to render the floor dry for the placement of the embankment fill or concrete as applicable, as directed by the Employer's Agent.

Should seepage flows be strong, the Employer's Agent may require that 100 mm or 150 mm perforated pipe drains in crushed stone surrounded by filter fabric be laid in place of open drains. Any strong springs encountered in the bed of the excavation shall be piped to these drains by excavating to 300 mm below the excavation floor level at the springs, placing crushed stone surrounded by filter fabric in the pit excavated and laying pipes from the pit to the nearest drain. The stone filling and the pipes shall then be covered with a 100 mm layer of concrete.

The Employer's Agent may direct that pumping sumps in the cut off be extended through the backfill to above original ground level by the use of pipes. Once the fill has reached original ground level, the pipes shall be grouted up with mortar or concrete. 50 mm grout pipes shall be run from the pit and drains to above original ground level, and once the area has been backfilled to a level above ground water level the drains and springs shall be grouted until tight with a cement mortar grout. Before backfilling commences it may be necessary to treat "weeping" or weak area with a layer of dry 1:2 mortar or cement stabilised earth.

Alternatively the Employer's Agent may direct that a grout cap be formed with dense concrete."

5.2.3 Placing and compaction (Subclause 5.2.3)

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5.2.3.1 Embankment (Subclause 5.2.3.2)

In Subclause d) remove the word "Proctor" and replace with "Modified AASHTO Maximum Dry Density (MAMDD)".

Add the following:

"Before any material is placed in each zone, the Contractor shall submit for approval by the Employer's Agent, a compaction procedure including details of type of plant, amount of plant, supervision and control. Approval by the Employer's Agent shall not relieve the Contractor of his responsibility to achieve the required density and moisture control.

Immediately after each layer of material has been conditioned to the required moisture content it shall be compacted to the specified density by compacting equipment approved by the Employer's Agent.

Successive loads shall not track each other on top of the fill, and there shall be no unnecessary concentration of travel tending to cause laminations, over compactions or uneven compaction within the fill. Where such lamination, over-compaction and unevenness do occur they shall be corrected to the satisfaction of the Employer's Agent before placing the next layer.

Should the material on the embankment become too dry or too wet as a result of interruption in the work, rain or other cause, all the affected material shall be removed or reworked (by scarifying, watering and curing as required) as directed by the Employer's Agent.

Rollers used for compaction of core material shall be of the sheepsfoot or padfoot type as specified in Subclause 4.2.2.

A systematic procedure for rolling shall be established and followed. The roller shall pass over each part of every layer as many times as may be necessary to break up the clods and compact the material properly. Rolling shall be done in a direction parallel to the centreline of the embankment, except as otherwise required. In general, rolling shall closely follow spreading, and no dumping will be allowed in areas where rollers and spreaders are operating. Roller paths shall overlap.

Layers of fill shall be spread to a maximum thickness of 150 mm. The embankment fill (Zone G6* and G7* of G7std) shall be compacted to 95% of MAMDD.

The mean density as determined from a number of tests shall be higher than or equal to the specified density. Additionally, no one density may be lower than 93%.

The compaction shall be tested in accordance with the requirements in terms of Clause 7 of SANS 1200 DE and its amendments below.

Cognisance should be made of the additional specifications and requirements, as in Particular Specification SPE-GG-001 for the placement of geosynthetics which form part of the embankment, for its strengthening."

5.2.3.2 Rockfill, rip-rap, drains and filters (Subclause 5.2.3.3)

Add the following to Subclause 5.2.3.3 d)

"Nowhere will the nominal thickness of the filter layer be less than indicated on the drawings due to the stepping. The width of the step must be increased to counteract any narrowing caused by the stepping and the cost of the additional material is to the Contractor's account.

The material in all sand blankets shall be compacted in layers not exceeding 300 mm in thickness by means of 2 passes of a vibrating compactor, or by other approved means."

Add the following at the end of the Subclause:

"g) The material for the Zone: Sand blanket drain shall adhere to requirements as per Subclause 5.2.3.2.

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[redacted]

h) When successive layers of sand fill are placed, the lower layer shall not be walked on and shall, as far as is possible, not be disturbed. Care shall be taken to prevent the contamination of permeable material during construction of the subsurface drains, and all permeable material contaminated by soil or silt shall be removed and replaced by the Contractor at his expense."

5.2.3.3 Backfilling around structures (outlet works) (Subclause 5.2.3.4)

Add the following at the end of the first sentence:

", which permission will not be given less than 7 days after the concrete for the structure has been cast."

Add the following at the end of the Subclause:

"c) Structures considered as part of the "outlet works" contemplated as part of this Subclause include: galleries, concrete encasements to any pipework in or under the embankment fill, outlet chambers.

5.2.3.4 Topsoiling

Add the following:

"Where required, on the downstream slope, the total topsoil zone shall be placed to a minimum thickness of 150 mm. The topsoil zone consists of a blend of topsoil material as removed during cleaning of the solum, and 50% (by volume) Zone G6* material."

5.2.4 Transport for Earthworks (Subclause 5.2.5)

Replace the contents of this Subclause with the following:

"The transport of all materials, irrespective of the distance and source, shall be deemed to be free-haul, the cost of which is included in the Contractor's tendered rates and prices for importation or disposal of materials. No separate compensation shall apply for the transportation of and double handling of materials."

6 TOLERANCES (CLAUSE 6)

6.1 POSITIONS, LEVELS, DIMENSIONS, AND MOISTURE CONTENT (SUBCLAUSE 6.2)

*Replace 6.2 a) 1) to 8) with the below table. Amended values noted with a " * " and other values reprinted for ease of reference.*

Item	Permissible deviation from designated dimensions (or mm if not indicated)
1) Embankment crest level *	+100, -0
2) Horizontal crest width	±300
3) Horizontal width of earthfill zones	+300, -100
4) Thickness of filter and drainage layers	+100, -0
5) Topsoil thickness on downstream face	+50, -0
6) Horizontal position of earthfill zones on upstream face and supporting zones *	±35
7) Gravel capping	-0, no top limit

At the end of paragraph a) add the following:

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[redacted]

"More onerous requirements specified elsewhere will supersede the above permissible deviations, for example those for foundations of concrete structures (amendments to SANS 1200G) or excavations for such (amendments to SANS 1200D).

Settlement allowance. With reference to the above, the Contractor shall allow for settlement during construction and ensure that all final levels at the end of construction are within the specified tolerances for line and level including the settlement allowance. The addition of thin veneers of fill to bring slopes to level will not be accepted.

The allowance for settlement of the embankment after construction shall be 1% of embankment height. The Contractor shall set out the slope grades and the crest camber to compensate for this settlement allowance.

The crest shall finally be trimmed to produce an even neat appearance to the approval of the Employer's Agent."

In paragraph b) replace the following values in the table as follows:

"1) Zone G6* and Zone G7* and Zone G7std fill material..... + 2, - 0

2) Sand filter material .....as directed by Employer's Agent"

7 TESTING (CLAUSE 7)

7.1 TAKING AND TESTING OF SAMPLES (SUBCLAUSE 7.2)

Add the following at the end of the subclause:

"The type and frequency of tests required to be undertaken by the Contractor are given in Table D 1.

Table D 1

TYPE AND FREQUENCY OF TESTS

Material	Test	Minimum Frequency of Testing
Embankment zones	Moisture content	One test per 1 000 m^3
	Gradation and Atterberg limits after compaction	One test per 2 000 m^3
	Field density	One test per 1 000 m^3
	MAMDD compaction	One per day per source
	Shear strength	One test per 5 000 m^3
Filter/Drain zones	Complete particle size distribution	Once at the initiation of construction at contact zones [1)] Once per 500 m^3
	Permeability	One test per 2 000 m^3

1) a complete particle size distribution of the in-situ material is to be carried out to enable the Employer's Agent to confirm the grading envelope for the adjoining filter materials. This will be deemed included under item 8.2.5 k) as below.

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In addition, whenever the source or batch of a material is changed, it must be tested.

The frequency of testing may be altered by the Employer's Agent if he is not satisfied that the quality and compaction of any material can be guaranteed by the frequency stated in Table D 1.

The compaction shall be tested in accordance with the sand replacement method (TMH1 Test Method A10 (a)). Testing with nuclear density testing apparatus, operated by a qualified technician, may be permitted if it can be shown to be consistent with regard to field densities and moisture contents when compared to the sand replacement method. The Contractor shall also provide a recent valid Calibration Certificate for the device.

The Contractor may use this device to conduct his routine density control and moisture content control tests. It does, however, not exempt him from his responsibility to achieve the specified density and moisture content. The Contractor shall conduct moisture content control tests in his laboratory to check the results obtained from the nuclear device.

The Employer's Agent shall observe the density control tests and may instruct further control tests to be conducted. The Contractor shall make the device and operator available to the Employer's Agent for his control tests.

The costs of any control tests conducted by the Employer's Agent, which results do not conform to the requirements, shall be for the Contractor's account."

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 COMPUTATION OF QUANTITIES (SUBCLAUSE 8.2)

Add at the end of Subclause 8.2.1:

"With reference to the provisions of this subclause, volumes will be calculated to the theoretical levels shown on the drawings and no extra payment will be made for providing and placing the additional material required for the settlement allowance specified in Subclause 6.2 or due to over-excavation unless directed by the Employer's Agent."

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.2.1 Site preparation (Subclause 8.3.1)

Replace the contents of Subclause 8.3.1 with the following:

"Where site preparation such as clearing, grubbing, the removal of large trees or the removal and stockpiling of topsoil is required, the provisions and scheduled items of SANS 1200 C shall apply."

8.2.2 Excavation (Subclause 8.3.3)

Replace the contents of this Subclause with the following:

"Where excavation is required the provisions and scheduled items of SANS 1200 D shall apply."

8.2.3 Preparation of exposed surfaces (Subclause 8.3.4)

Add the following after item b):

"c) Drainage ..... Unit: m^2"

In the last line replace "and (b)" with ", (b) and (c)"

8.2.4 Forming embankment (Subclause 8.3.5)

Add after Item "h) Gravel Capping: "

i) Importation of embankment fill Pioneer layer: Zone G6* ..... Unit: m^3

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[redacted]

j) Importation of Embankment fill: Zone G7* ..... Unit: m³

k) Importation of Embankment fill: Zone G7std (provisional) ..... Until m³

l) Importation of sand blanket: Sand blanket drain ..... Until m³"

Add the following at the end of the subclause:

"The tendered rate for imported materials shall also include for the costs of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, stockpiling, for spreading, backfilling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications. No payment will be made for the removal of overburden or stockpiling at the commercial source.

All associated costs of installation of geosynthetic materials for the strengthening of the embankment will, including special surface preparations and interruption of the programme for the geosynthetics, will not be measured in the cost for forming the embankment, but as in the scheduled rates and their Particular Specifications for geosynthetics.

The Employer's Agent may alter the boundaries of the zones of the embankment and no payment over and above the tendered rates or prices will be made to the Contractor on account of such alterations.

Any excavation, re-filling and compacting of material for diversion channels or any other excavations, which the Contractor may require for his own purposes, will not be measured.

The rate shall also cover the cost of the provision and maintenance of all haul roads, the re-working of material already placed on the embankment that has become unsatisfactory during interruption to the construction programme, and all control tests on embankment materials, in situ density tests and moisture content control tests and taking into account all necessary delays to construction during the taking of these tests by the Contractor or the Employer's Agent.

Under this Subclause no separate payment will be made for excavation, but where applicable (essential excavations only) payment will be made under 8.3.3."

8.2.5 Overhaul (Subclause 8.3.8)

Delete this Subclause.

The transport of all materials, irrespective of the distance and source, shall be deemed to be free-haul as defined in 5.2.5.

8.2.6 Topsoiling (Subclause 8.3.9)

Change the unit to "m³" and replace the contents of this Subclause with the following:

"The unit of measurement shall be the cubic metre and the quantity shall be calculated from the authorised dimensions.

The tendered rate shall include loading of the topsoil from stockpiles, blending with 50% by volume of Zone G6*, supply of the Zone G6* to be blended, transporting, and off-loading, spreading, shaping and lightly compacting the topsoil."

Add in the following clause at the end of 8.3:

8.2.7 Grass or other vegetation cover (Subclause 8.3.11)

Grass or other vegetation cover will be measured by the area over which an established grass or other vegetation cover has specified.

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The rate shall cover the cost of supplying, planting, watering, fertilizing and maintaining the grass or other vegetation for the duration of the Works."

9 DRAWINGS

9.1 CLASSES OF EXCAVATION (FIGURE DE-1)

Replace Figure DE-1 with the following figure:

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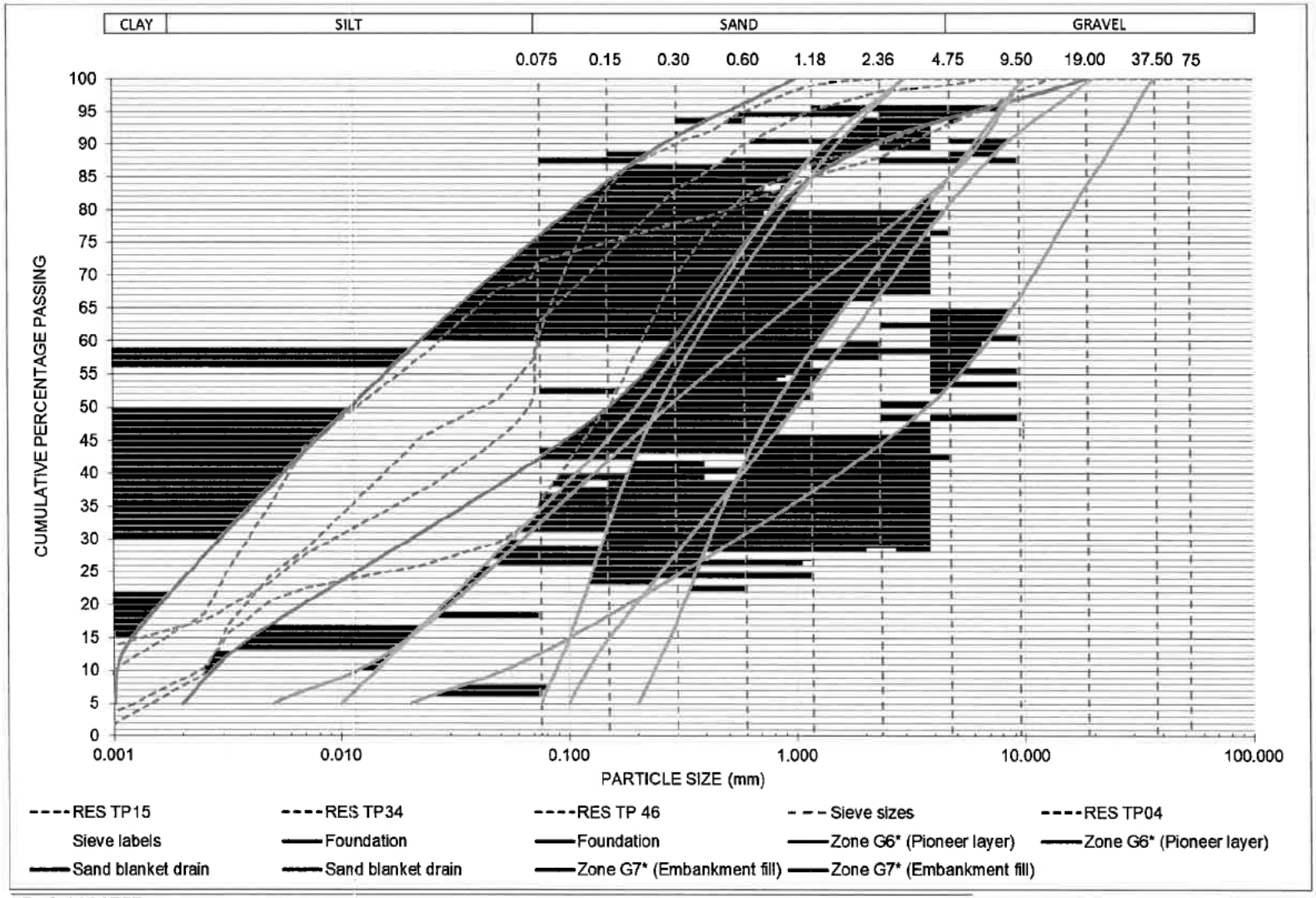


Figure DE-01

Foundation sample grading results (RES TP15,34,46) also indicated for information.

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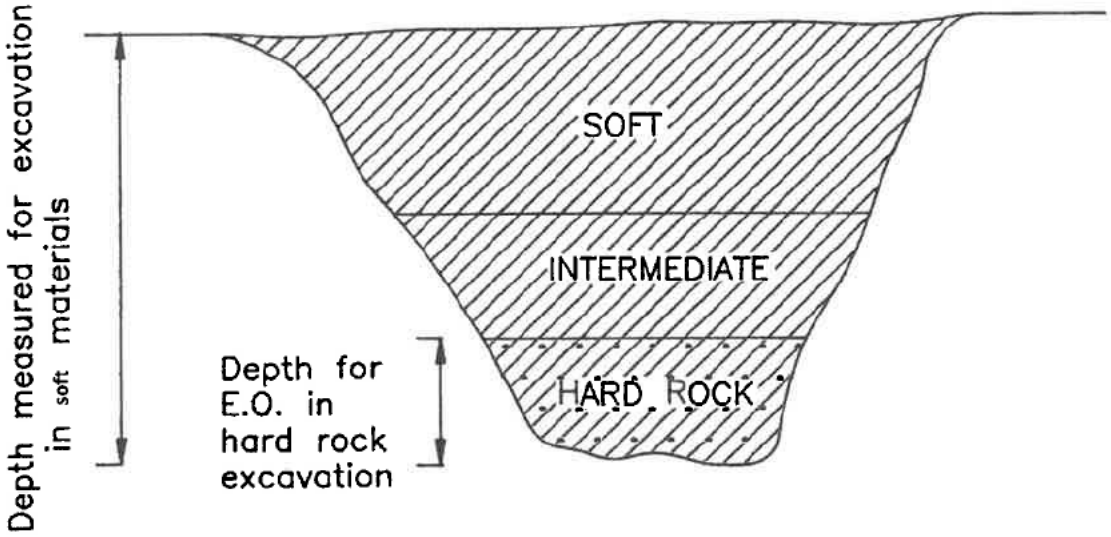


Fig. D–1 – Classes of Excavation: Measurement and Payment

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1. SCOPE (CLAUSE 1)

Replace the first paragraph of this Clause with the following:

"This specification covers the construction of gabions, stone pitching and rip-rap for the protection of earthworks against erosion. It covers gabion walls and aprons used as retaining walls, channel linings, and the like. It also covers rock rip-rap, used as channel linings, and light to heavy stone pitching, with and without mortar."

2. INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (Subclause 2.3)

Add the following to the end of this Subclause:

"**2.3.10 Rip-rap**: Rock of specified quality and grading placed in layers of specified thickness as erosion protection."

3. MATERIALS (CLAUSE 3)

3.1 Gabions (Subclause 3.1)

3.1.1 Stone (Subclause 3.1.1)

Add the following after the heading of Subclause 3.1.1.1:

"Stone for gabions must be obtained from commercial sources and be approved by the Employer's Agent. Such stone shall be clean and free of foreign matter and, blend in with the environment."

3.1.2 Gabion Cages (Subclause 3.1.2)

Add the following at the end of this Subclause:

"Gabion boxes shall comply with the following:

i. Double twisted hexagonal wire Mesh Type 80 gabions of nominal 80mm mesh, with 2.7mm diameter mesh wire, complete with partitions at 1m centres.

ii. All wire shall be mild steel to SANS 1580:2010, zinc coated by hot-dip galvanizing to SANS 675:2011 and bonded with heavy duty PVC coting of nominal 0.5mm wall thickness to SANS 1580:2010.

Wire for boxes				
Use	**Units**	**For lacing**	**For mesh**	**For selvedge**
Galvan + PVC	Ø mm	2,2 / 3,2	2,7 / 3,7	3,4 / 4,4
Wire tolerance *	Ø mm	±0,08	±0,08	±0,1
Quantity of Galfan **	g/m²	230	245	265
Tensile strength ***	N/mm²	350 – 575		
* To SANS 675 / ** To EN 102442-2, Table 2, Class A / *** To SANS 1580 and SANS 675				

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[redacted]

Gabion mattresses shall comply with the following :

iii. Double twisted hexagonal wire Mesh Type 60 gabions of nominal 60mm mesh, with 2.2mm diameter mesh wire, complete with partitions at 1m centres.

iv. All wire shall be mild steel to SANS 1580:2010, zinc coated by hot-dip galvanizing to SANS 675:2011 and bonded with heavy duty PVC coting of nominal 0.5mm wall thickness to SANS 1580:2010."

Wire for mattresses				
Use	**Units**	**For lacing**	**For mesh**	**For selvedge**
Galvan + PVC	Ø mm	2,2 / 3,2	2,2 / 3,2	2,7 / 3,7
Wire tolerance *	Ø mm	±0,08	±0,08	±0,08
Quantity of Galfan **	g/m²	230	230	245
Tensile strength ***	N/mm²	350 – 575		
* To SANS 675 / ** To EN 102442-2, Table 2, Class A / *** To SANS 1580 and SANS 675				

3.1.3 Geotextile (Subclause 3.1.3)

Replace the last sentence with the following:

"The make and grade of the geotextile shall, as a minimum, comply with that specified on the drawings and in the Schedule of Quantities."

Add at the end of the Subclause:

"The geotextile used under and on the sides of the gabions and mattresses shall consist of continuous filament double needle punched geotextile.

Gabion AG 200 or similar approved shall be used underneath and on the sides of gabions and mattresses. Gabion AG 400 or similar approved shall be used where rock protection (rip-rap) is placed.

The geotextile blanket used beneath the reno mattresses shall have a mass of at least 210g/m2 and a minimum strength of 10kN/m in all directions ("Kaymat U24" or equal approved), with overlaps of at least 300mm.

The synthetic-fibre filter fabric is classified according to the mechanical properties thereof, viz its penetration load, puncture resistance and the minimum water percolation rate as measured in the permeability test. Table 3.1 shall be used for determining the grade of a synthetic-fibre filter fabric.

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TABLE 3.1
GRADE CLASSIFICATIONS OF SYNTHETIC-FIBRE FILTER FABRIC

PROPERTY	GRADE			TEST METHOD
	1	2	3	
Penetration load (minimum), N	3900	2500	1600	SANS 10221
Puncture resistance (maximum), mm	14	26	32	EN ISO 13433
Water percolation (minimum), ℓ/m²/s	70	70	145	SANS 10221

Notes: The standard atmosphere for testing and the preconditioning atmosphere for all synthetic-fibre filter fabric tests (SANS tests and other) shall have a relative humidity falling within the range of 10 to 50 per cent and a temperature within the range of 15°C to 50°C.

The resistance of a synthetic-fibre filter fabric to puncture is the average diameter of the hole formed when a 45° cone with a mass of 1 kg is dropped through 500 mm on to the synthetic-fibre filter fabric fixed in the holding device. The test method and parameters shall be in accordance with EN ISO 13443.

The synthetic-fibre filter fabric shall withstand the level of aggressiveness of the soil and ground water given below without significant loss of its strength and hydraulic properties during its design life of 25 years:

- Soil and ground water with a pH in the range of 4 to 12 (pH to be determined by Method A20, TMH1, 1986); and
- Soil (as paste) and ground water containing salts with a conductance of up to 1.0 S/m (conductivity to be determined by Method A21T, TMH1, 1986).

The synthetic-fibre filter fabric shall maintain at least 80% of its original strength after direct exposure to sunlight of 1 500 hours.

The synthetic-fibre filter fabric shall be entirely rot-proof and shall not support the growth of algae.

The synthetic-fibre filter fabric required shall satisfy the criteria for grade 1, 2 or 3 synthetic-fibre filter fabric as listed in the Schedule of Quantities or specified on the Drawings.

The Contractor shall, at least 28 days before the installation of the synthetic-fibre filter fabric, submit to the Employer's Agent samples of the synthetic-fibre filter fabric he proposes to use, for review and approval by the Employer's Agent."

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3.1.4 Tensioning frames for gabion baskets (New Subclause 3.1.6)

The Contractor shall supply one set of tensioning frames for gabion baskets.

3.2 PITCHING (SUBCLAUSE 3.2)

3.2.1 Stone (Subclause 3.2.1)

Replace the contents of Table 2 with the following:

TABLE 2: SIZE AND MASS OF INDIVIDUAL STONES FOR PITCHING			
1	2	3	4
Size/mass of Pitching	Thickness of pitching mm, min	Least dimension mm, min	Mass kg, min
Extra heavy	600	300	180
Heavy	400	190	50
Medium	300	150	27
Light	200	110	11

3.3 RIP-RAP (NEW SUBCLAUSE 3.3)

3.3.1 Stone (New Subclause 3.3.1)

Stone for rip-rap must be obtained from commercial sources and be approved by the Employer's Agent. Such stone shall be clean and free of foreign matter and, blend in with the environment. The stone size shall be as shown in the table below:

STONE SIZES FOR RIP-RAP

RANGE OF STONE SIZE (IN TERMS OF D_{50} STONE SIZE)	FRACTION OF TOTAL WEIGHT SMALLER THAN THE GIVEN SIZE (%)
1.50 - 2.00 D_{50}	100
1.30 - 1.80 D_{50}	85
1.00 - 1.50 D_{50}	60
0.30 - 0.50 D_{50}	15

THE D_{50} STONE SIZE FOR RIP-RAP SHALL BE AS SPECIFIED ON THE DRAWINGS.

3.3.2 Filter Layers (New Subclause 3.3.2)

Where specified on the Drawings, or ordered by the Employer's Agent, filter layers shall be provided between the bottom of the rip-rap layer and the surface that it is intended to protect. The filter material shall be sand, gravel or crushed stone, as appropriate to meet the grading requirements shown on the Drawings, and as approved by the Employer's Agent.

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4. PLANT (CLAUSE 4)

No amendments.

5. CONSTRUCTION (CLAUSE 5)

5.1 GABION CAGES (SUBCLAUSE 5.1)

5.1.1 Binding and Connecting Wire (Subclause 5.1.1)

ADD THE FOLLOWING TO SUBCLAUSE 5.1.1:

"The standard method of securing the binding wire shall be as follows:

i. Begin wiring up by securing the binding wire at the top corners of the panels to be joined by looping it through and twisting together.
ii. Then lace the wire around the selvedge's with single loops and double loops in turn at 100mm intervals.
iii. Finally, fasten the wire securely at the bottom corner, and poke the loose end inside the case. The cases shall be wired together using the exact method as for assembling single cases as described above.
iv. Binding wire shall be similar to the box or mattress wire as stated above."

5.1.2 Gabion and mattress installation training (New Subclause 5.1.3)

The Contractor shall arrange with a representative from the supplier of the gabions for all workers involved with the installation of gabions and mattress to receive on-site training, which will be provided by the representative from the gabion supplier. Attendance will be compulsory.

5.1.3 Construction of trial gabion section (New Subclause 5.1.4)

A 3 m trial length of 1,0 x 1,0 m gabion baskets shall be constructed at the Site to the satisfaction of the Employers Agent and a representative from the supplier.

The approved trial section will be used as the benchmark for future work and photographs of the trial section will be kept on Site, to ensure that the quality of work is comparable with the benchmark. The Employer's Agent reserves the right to reject work that does not meet the benchmark and such work will be dismantled by the Contractor and re-done.

5.2 GABION WALLS AND APRONS (SUBCLAUSE 5.2)

5.2.1 Geotextile or Geomembrane (Subclause 5.2.2)

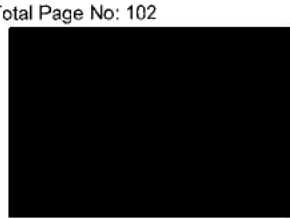
Add the following to Subclause 5.2.2:

"Geotextile fabric shall be placed at all interfaces between gabions and the ground."

5.2.2 General (New Subclause 5.2.8)

In addition to the above, gabion mattresses and boxes shall be installed strictly in accordance with the approved manufacturer's installation guidelines and the Contractor shall ensure that sufficient pliers, nippers, Spenax tools as well as closing tools are available for use by his labour force.

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5.3 PITCHING (SUBCLAUSE 5.3)

5.3.1 General (Subclause 5.3.1)

Notwithstanding the provisions of this Clause the excavation footing trench shall be backfilled with class 20/19 concrete to the proposed top level of the pitching.

5.3.2 Plain pitching (Subclause 5.3.2)

Add the following:

"The exposed stone surfaces shall be cleaned of excess mortar within 1 day of being grouted."

5.3.3 Grouted pitching (Subclause 5.3.3)

Add the following:

"The exposed stone surfaces shall be cleaned of excess mortar within 1 day of being grouted."

Replace the words "(see table 4)" *in the second line of the third paragraph with* "(see table 2)".

5.4 RIP-RAP (NEW SUBCLAUSE 5.4)

5.4.1 Placing of rip-rap (New Subclause 5.4.1)

Rip-rap shall be placed in layers of the thicknesses specified on the Drawings so as to minimise the spaces between the rocks and to obtain a relatively even surface to the top of the rip-rap layer, with no rock protruding more than 150 mm above the general surface level.

6. TOLERANCES (CLAUSE 6)

Notwithstanding the provisions of this Clause, the materials, and the finish of the work applicable to all gabion work shall be to Degree of Accuracy I and the permissible deviations shall be within the limits given for a Degree of Accuracy I.

7. TESTS (CLAUSE 7)

7.1 Taking and testing of samples (SUBCLAUSE 7.1)

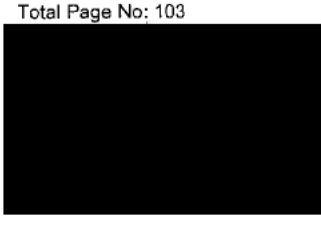
Delete the contents of Subclause 7.1 and replace with the following:

"The Contractor shall carry out sufficient tests to satisfy himself as to the consistency of the materials used for and placed in gabion cages or used for pitching or rip-rap.

The stone supplied for the contract shall conform to the test procedures and parameters stated under 7.3.

Stone from dolomitic sources shall also satisfy the durability test described in 7.4. The cost of the tests will be deemed to be included in the rates for gabions and mattresses and stone pitching."

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8. MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 PRINCIPLES (SUBCLAUSE 8.1)

Delete the contents of this Subclause and replace with the following:

8.1.1 "Computation of quantities for excavation

The relevant principles and computation of quantities set out in 8.1 and 8.2 of SANS 1200 DA, shall apply to excavations.

8.1.2 Tensioning frames for gabion baskets

The cost of providing tensioning frames for installing gabion baskets shall be deemed to be included in the tendered rate for gabions.

8.1.3 Installation training for gabions and mattresses

The cost of attending the compulsory on-site training session will be deemed to be included in the tendered rates supplying and installing gabions and mattresses.

8.1.4 Construction of trial gabion structure

The cost of constructing the trial gabion section will be deemed to be included in the tendered rate for supplying and installing gabions."

8.2 Scheduled items (Subclause 8.2)

Replace the heading and contents of Clause 8.2.1 with the following:

8.2.1 Surface preparation for bedding of gabions (Subclause 8.2.1)..... Unit m^2

The rate tendered shall cover the cost of all labour, plant and equipment required to effect minor shaping as well as compact any loose material to leave a firm surface, ready for bedding the gabion cages, mattresses, and pitching."

8.2.2 Pitching (Subclause 8.2.5)..... Unit m^3

The rates tendered shall cover the cost of excavating footing trenches over the lengths, widths and depths ordered as if in soft material, trimming trenches, compacting inverts, class 20/19 concrete backfill, as well as the cost of loading, transporting within a free haul distance of 0,5km and disposal of excavation material as directed.

The volume will be computed from the dimensions ordered. No payment will be made for over-excavation or resultant additional concrete backfill."

8.2.3 Rip-rap (New Subclause 8.2.8) .....Unit m^3

The rate for rip-rap shall cover the cost of supplying and placing the rip-rap in a uniform layer of specified thickness to the satisfaction of the Employer's Agent.

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[redacted]

8.2.4 Geotextile beneath rip-rap (New Subclause 8.2.9) .....Unit m^2

The area measured will be the area of the rip-rap layers ordered or shown on the Drawings to be underlain by geotextile. The rate shall cover the cost of supplying geotextile of the specified grade, cutting, waste, placing, joining, overlapping, and fastening the geotextile in position.

8.2.5 Sand layer on top of geotextile layer (New Subclause 8.2.10) .....Unit m^2

The area measured will be the area of the geotextile covered by the sand layer as ordered or shown on the Drawings.

8.2.6 Filter layers beneath rip-rap (New Subclause 8.2.11) .....Unit m^2

The area measured will be the area of each filter layer of specified grading and thickness ordered, or shown on the Drawings, to be placed beneath the rip-rap layer.

8.2.7 Cutting and Adjusting mattress to fit around stormwater pipe (New Subclause 8.2.12)..Unit m^2

The rate shall cover the cost of cutting the cages, adjusting the wires, and securing all around the stormwater pipe.

8.2.8 Excavation and concrete backfill of footing trenches for pitching (New Subclause 8.2.13) .....Unit m^3

The rates tendered shall cover the cost of excavating footing trenches over the lengths, widths and depths ordered as if in soft material, trimming trenches, compacting inverts, class 20/20 concrete backfill, as well as the cost of loading, transporting within a free haul distance of 0,5km and disposal of excavation material as directed.

The volume will be computed from the dimensions ordered. No payment will be made for over-excavation or resultant additional concrete backfill."

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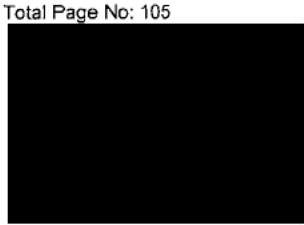


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To [redacted]

1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS AND ABBREVIATIONS (SUBCLAUSE 2.3)

Notwithstanding the definition of roadbed given under Clause 2.2 of SANS 1200 M, all in-situ surfaces requiring compaction as indicated on the drawings, shall be classified as roadbed.

3 MATERIALS (CLAUSE 3)

3.1 CLASSIFICATION FOR EXCAVATION PURPOSES (SUBCLAUSE 3.2)

Notwithstanding the provisions of this Clause, the excavation of material will, for purposes of measurement and payment, be classified as specified in subclause 3.1.2 of SANS 1200D.

3.2 CLASSIFICATION FOR PLACING PURPOSES (SUBCLAUSE 3.2)

3.2.1 Fill (Subclause 3.2.2)

Notwithstanding the requirements of this Clause, material from commercial sources or borrow pits located by the Contractor, to be used in the fill, shall comply with the requirements of subclause 3.2.3.

3.2.2 Selected layer (Subclause 3.2.3)

Replace the contents of this Subclause with the following:

"The following requirements shall apply in respect of the selected layer:

a) Maximum particle size: 60% of compacted layer thickness

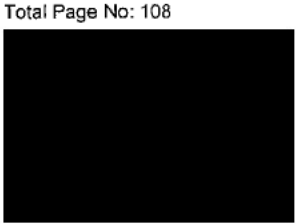
b) Unstabilized selected layer:
   1) Upper selected layer
      Minimum CBR at 93% of modified AASHTO density: 15
      Maximum PI: 12 (the Employer's Agent has the right to alter this requirement to 3 x the grading modulus + 10)
      NOTE: These requirements for the upper selected layer also apply where only one unstabilized selected layer is specified.
   2) Lower selected layer
      Minimum CBR at 90% of modified AASHTO density: 7
      Maximum PI: 12 (the Employer's Agent has the right to alter this requirement to 3 x the grading modulus + 10)

c) For stabilized selected layer:
   Minimum grading modulus of natural material: 0,75
   UCS of stabilized material 300 kPa - 500 kPa at 93% of modified AASHTO density
   Maximum PI for stabilized material: 10"

3.3 SELECTION (SUBCLAUSE 3.3)

Notwithstanding the provisions of this Clause, the Contractor shall note that the excavation from the cutting shall be utilized for the construction of the lower layers of fills.

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4 PLANT (CLAUSE 4)

No Amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 METHODS AND PROCEDURES (SUBCLAUSE 5.2)

5.1.1 Cut and borrow (Subclause 5.2.2)

5.1.1.1 Dimensions of cuts (Subclause 5.2.2.2)

Delete "suitable material .....7" in the fifth line and replace with "material complying with subclause 3.2.3 ."

Add after "drawings" in the second line of this subclause "which shall include for road side channels, cross drains and sidewalks within the road reserve".

5.1.1.2 Use of Material (Subclause 5.2.2.3)

Add after "borrow pits" in the second line of subclause (d): "or commercial sources."

Add the following after subclause (d):

"(e) Commercial sources

The provisions of subclause 5.2.2.5 of SANS 1200 D as amended shall apply."

5.1.1.3 Disposal of surplus or unsuitable material (Subclause 5.2.2.5)

Add after "directed" in the second line of this Clause "(refer subclause PSD 5.2.2.3 of SANS1200D)".

5.1.1.4 Catchwater mounds and channels and mitre banks and channels (Subclause 5.2.2.6)

Add the following to the end of this Subclause:

"Catchwater mounds and mitre banks shall be compacted to a minimum density of 90% of modified AASHTO density."

5.1.2 Treatment of the road-bed (Subclause 5.2.3)

5.1.2.1 Removal of unsuitable ground (Subclause 5.2.3.2)

Replace the second sentence of paragraph (a) with the following:

"The excavated spaces shall then be backfilled with approved imported material or material from other excavations compacted to the required density."

Add the following sentence to paragraph (b):

"Unsuitable excavated material will be paid for as cut to spoil."

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5.1.2.2 Treatment of road-bed (Subclause 5.2.3.3)

Add the following to Clause (a):

"The depth of compaction shall be 150mm."

Add the following paragraph to the end of this Subclause:

"(c) Three-pass roller compaction
Any portion of the roadbed that is shown on the Drawings or is specified or is directed by the Employer's Agent to be given three-pass roller compaction because of its inadequate natural density, shall be prepared by shaping where necessary and compacting with a roller, complying with the requirements specified below.

Compaction shall comprise three complete coverages by the wheels of the specified roller over every portion of the area that is being compacted. While it is not the intention that the Contractor should apply water to the roadbed for this type of compaction, and while no rigid moisture control will be exercised during compaction, the Contractor shall nevertheless satisfy the Employer's Agent that everything is being done to take full advantage of favourable soil moisture conditions during the rainy season, and that such compaction is as far as possible carried out when the roadbed is neither excessively dry nor excessively wet.

The Employer's Agent has the authority to decide when conditions are favourable for compaction and where such compaction is to be carried out at any particular time, and he has the right to instruct the Contractor to water the roadbed at the Contractor's expense when, in the opinion of the Employer's Agent, the Contractor failed, neglected, or refused to comply with these requirements.

The rollers to be used for roller-pass compaction shall conform to the following requirements:

Grid roller: The grid roller shall have a mass of not less than 13,5 t when ballasted, shall be loaded to this mass if required, and shall be moved at a speed of not less than 12 km/h.

Vibratory roller: The vibratory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/m width for every metre of loose-layer thickness at an operating frequency not exceeding 25 Hz and shall move at a speed not exceeding 4 km/h."

5.1.3 Fill (Subclause 5.2.4)

5.1.3.1 Finishing (Subclause 5.2.4.3)

Add the following below the heading of this subclause:

"Notwithstanding the provisions of this Clause the requirements of subclause 5.2.9 shall as applicable apply to the finishing off of verges."

Replace the second sentence of Subclause 5.2.4.3(e) Topsoiling with the following:

"The thickness of the topsoil shall be as directed by the Employer's Agent."

5.1.3.2 Selected layer (Subclause 5.2.5)

Replace the contents of this Subclause with the following:

"Except with regard to density, the requirements of subclause 5.2.4 shall apply. The degree of compaction shall be:

Upper selected / Selected	: 95% of modified AASHTO maximum	density.
Lower selected	: 93% of modified AASHTO maximum	density."

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5.1.3.3 Gravel surfacing (Subclause 5.2.6)

Replace the third sentence of this Subclause with the following:

"The relevant requirements of subclause 5.2.4.2 shall apply, except that the material shall be compacted to 93% of modified AASHTO density."

5.1.3.4 Transport (Subclause 5.2.8)

Replace the contents of this Subclause with the following:

"The provisions of Subclause 5.2.5 of SANS 1200 D shall apply."

Add the following new subclauses:

5.1.3.5 Trimming and grading of verges (New Subclause 5.2.9)

During the initial earthworks the verge width shall be cut or filled to approximately the final level and shall be kept trimmed and tidy during construction of the works. After completion of the road layers, including the premix surface, and after construction of the necessary kerbs, including the satisfactory backfilling behind the kerb, the verge shall be finished off to the lines and levels shown on the drawings or as specified.

The verge material shall consist of that material which would normally be occurring at that position or depth when in cut and shall not be contaminated by foreign materials such as bricks, basecourse material, horticulturally inferior materials from trench excavation, etc. Verges in fill conditions are to consist of the material as specified for the fills and similarly not be contaminated with foreign materials.

Over those sections of verge where grass is to be planted in which case the Contractor shall load, transport and spread as ordered by the Employer's Agent. In the case of topsoil provided and imported by the Contractor the quality of the topsoil shall be approved of by the Employer's Agent beforehand.

The Contractor shall be responsible for taking the necessary precautions and measures to control the dust nuisance which may arise due to his operations on the verge, whether from the natural ground surface or topsoil layer, until the verge is accepted by the Employer's Agent.

5.1.3.6 Dimension and level control and process control (New Subclause 5.2.10)

The Contractor shall submit to the Employer's Agent records of dimension and level control and/or process control prior to requesting the Employer's Agent to carry out any routine tests and/or inspections.

A sample form can be obtained from the Employer's Agent.

5.1.3.7 Requesting of tests (New Subclause 5.2.11)

Tests and Inspections of the works will only be carried out by the Employer's Agent once the appropriate test/inspection request forms have been fully completed. Test/inspection request forms can be obtained from the Employer's Agent."

6 TOLERANCES (CLAUSE 6)

Add the following new subclause:

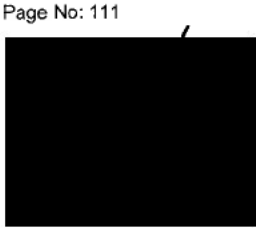
6.1 DIMENSION, LEVELS, ETC. (SUBCLAUSE 6.2)

6.1.1 Cut (Subclause 6.2.2)

Add the following to subclause 6.2.2:

"(d) Final level of all cuttings +0 mm to -50 mm."

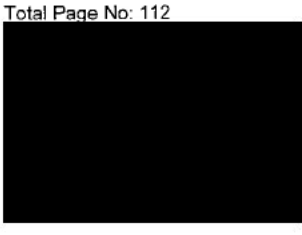
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6.2 DIMENSION AND LEVEL CONTROL (NEW SUBCLAUSE 6.5)

The requirements of PSM 6.4 shall apply."

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7 TESTING (CLAUSE 7)

7.1 ROUTINE INSPECTION AND TESTING (SUBCLAUSE 7.3)

Replace the contents of Subclause 7.3.2, including Table 2, with the following:

"The dry density requirements for a particular lot of selected layer or wearing course shall be deemed to be satisfied if the average density and the results of individual tests meet the requirements specified in Table 2 below. Refer to SANS 1200 DM, Subclause 7.2 for the requirements for fill.

TABLE 2 - DENSITIES

1	2	3	4	5
Layer	Specified density (% of modified AASHTO density)	Number of tests per lot	Average density %	Minimum density for any single test, %
Upper selected layer	95	3 and 4 5 6	95,1 95,4 95,6	91,4 91,2 91,0
Lower selected layer	93	3 and 4 5 6	93,1 93,4 93,6	89,4 89,2 89,0

"

Add the following new subclause:

7.2 INSPECTION AND TESTING BY EMPLOYER'S AGENT (NEW SUBCLAUSE 7.4)

The requirements of subclause 7.3 of SANS 1200M shall apply.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

Add the following:

"The requirements of item 8.2 shall apply. The Contractor shall further make provision in the various rates for the construction of the roadbed, fill and selected layer for the cost of his own process control testing and the cost of complying with subclause 6.5 and 7.4."

8.2 COMPUTATION OF QUANTITIES (SUBCLAUSE 8.2)

8.2.1 Volume Measured only Once (Subclause 8.2.1)

Replace the contents of this Subclause with the following:

"The provisions of Subclause 8.2.1 of SANS 1200 D shall apply."

8.2.2 Non-geometric Shaped Volumes (Subclause 8.2.2)

Replace the contents of this Subclause with the following:

"The provisions of Subclause 8.2.2 of SANS 1200 D shall apply."

8.2.3 Volumes Removed in Site Clearance and Topsoil (Subclause 8.2.3)

Replace the contents of this Subclause with the following:

"The provisions of Subclause 8.2.2 of SANS 1200 D shall apply."

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8.2.4 Verifying quantities (Subclause 8.2.5)

Replace the first sentence with the following:

"Before any earthworks are commenced but after completion of any site preparation, the Employer's Agent will, upon a written request from the Contractor, provide cross-sections for the purpose of measurement of earthworks quantities."

Add the following new subclause:

8.2.5 Cut to accommodate road side channels and channel cross drains within the road reserve (New Subclause 8.2.7)

The volume of material excavated to form road side channels and channel cross drains (including cut to accommodate concrete lining) within the road reserve, will be measured for payment as cut to fill, cut to spoil, or cut to selected layer, as the case may be."

8.3 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.3.1 Treatment of roadbed (Subclause 8.3.3)

*Add the following to the end of paragraph a), after the paragraph which ends with "*material if required.*"*

"The unit of measurement shall be the cubic metre of material recompacted as specified and the volume shall be determined from levelled cross-sections on which are superimposed the levels to which the roadbed is to be constructed. When material is imported to make up the required volume, such material will be paid for as cut or borrow to fill as relevant.

Add the following to the end of Subclause 8.3.3:

"(c) Three-pass roller compaction:

1) Grid roller ..... Unit: m²

2) Vibratory roller..... Unit: m²

The units of measurement shall be the square metre of roadbed compacted as specified in Subclause 5.2.3.3(c) as amended for the areas designated by the Employer's Agent.

The tendered rates shall include full compensation for shaping the areas, providing the rollers and compacting the roadbed by means of three roller passes over the entire area."

8.3.2 Cut to fill, borrow to fill (Subclause 8.3.4)

Replace the contents of this Clause with the following:

"(a) Cut to fill compacted to 93% of modified AASHTO maximum density..... Unit : m³

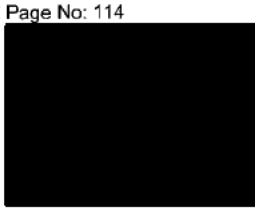
The rate tendered shall cover the cost of excavating from the site as if in soft material, transporting, preparing, processing, shaping (including forming road side channels and channel cross drains), watering, mixing, compacting to percentage of modified AASHTO maximum density specified, trimming, and testing the fill.

(b) Borrow to fill from commercial or off site sources located by the Contractor compacted to 93% of modified AASHTO maximum density..... Unit : m³

The rate tendered shall cover the cost of acquiring the material from commercial or off site sources located by the Contractor, any excavation and selection required, loading, transporting to the point of use irrespective of distance, temporary stockpiling if necessary, placing, watering, compacting to percentage of modified AASHTO maximum density specified, trimming, and testing the fill.

No additional payment will be made for difficult work or hand operations in confined areas."

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8.3.3 Selected layer compacted to 93% of modified AASHTO maximum density (Subclause 8.3.5)

Replace the heading of this item with the following:

"Selected layers:"

Replace the contents of this item with the following:

(a) Using material cut from the site and compacted to:

i. 93% of modified AASHTO maximum density..... Unit : m³

ii. 95% of modified AASHTO maximum density..... Unit : m³

The rate tendered shall cover the cost of excavating as if in soft material, selecting, loading, transporting, placing, watering, compacting to percentage of modified AASHTO maximum density specified, trimming and testing the selected layer.

(b) Using material from commercial or off site sources located by the Contractor, compacted to:

i. 93% of modified AASHTO maximum density..... Unit : m³

ii. 95% of modified AASHTO maximum density..... Unit : m³

The rate tendered shall cover the cost of acquiring the material from commercial or off site sources located by the Contractor, any excavation and selection required, loading, transporting to the point of use irrespective of distance, temporary stockpiling if necessary, placing, watering, compacting to percentage of modified AASHTO maximum density specified, trimming and testing the selected layer.

Separate items will be provided for material from each type of source.

Note :

No additional payment will be made for difficult work or hand operations in confined areas."

8.3.4 Extra over items 8.3.4 and 8.3.5 for excavating and breaking down material in (Subclause 8.3.6)

Replace this Subclause heading with the following:

"Extra over items 8.3.4, 8.3.5 and 8.3.16 for excavating and breaking down material in"

*Replace both "*a) Intermediate excavation*" and the corresponding unit of measure with "*a) Not applicable (VOID)". No extra-over payment will be made for excavation and breaking down material in intermediate excavation.

Replace the words "items 8.3.4 and 8.3.5" *in the final paragraph with the words* "items 8.3.4, 8.3.5 and 8.3.16".

8.3.5 Cut to spoil or stockpile from (Subclause 8.3.7)

Replace this Subclause heading with the following:

"Cut to spoil from"

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*Replace both "*b) Intermediate excavation*" and the corresponding unit of measure with "*b) Not applicable (VOID)".

Add the following:

Separate items will be scheduled for cut to spoil and cut to stockpile. The rate tendered shall further cover the cost of complying with the requirements of Clause 5.2.3.2 irrespective of the depth or extent of the material ordered to be removed, or whether the order to remove unsuitable material is given after the completion of any initial cut operation, with the exception of unsuitable material ordered to be removed from the completed cut surface of channel cross drains and road side channels which will be measured for payment under subclause 8.3.16 of SANS 1200D.

The tendered rate shall further, in the case of cut to spoil, include full compensation for transporting the material regardless of the distance involved and for all other incidental cost to dispose of the spoil material at a spoil site or spoil sites provided by the Contractor. (Refer also 5.2.2.3, 5.2.5 and 8.3.12)."

8.3.6 Overbreak of excavation in: (Subclause 8.3.9)

*Replace both "*a) Intermediate excavation*" and the corresponding unit of measure with "*a) Not applicable (VOID)". No extra-over payment will be made for overbreak of excavation in intermediate excavation.

8.3.7 Extra-over Items 8.3.2, 8.3.4 or 8.3.5 for temporary stockpiling of material (Subclause 8.3.11)

Replace the heading and the contents of Subclause 8.3.11 with the following:

Extra-over item 8.3.7 for temporary stockpiling of material (Subclause 8.3.11):
The unit of measurement shall be the cubic metre and the quantity will be calculated from the authorised dimensions of the compacted layer.

The tendered rates shall include full compensation for excavating the material as if in soft material for loading, transporting for the free-haul distance, for off-loading, spreading, watering, mixing, breaking down and compacting the layer."

8.3.8 Overhaul (Subclause 8.3.12)

Delete this Subclause.

No overhaul will be paid on material from commercial sources or borrow pits selected by the Contractor for the purposes of this Contract and all the costs for transporting such material shall be included in the applicable tendered rates and amounts.

8.3.9 Surface finishes (Subclause 8.3.13)

Replace the contents of subclause 8.3.13 with the following:

(a) Topsoiling

(i) Topsoiling (from stockpile)..... Unit: m^2

(ii) Topsoiling (from commercial sources)..... Unit: m^2

The rate shall cover the costs of excavating from stockpiles formed in terms of subclause 5.2.1 and hauling and spreading in terms of Subclauses 5.2.4.2 of SANS 1200 D and Subclause 5.2.5.2 of SANS 1200 DA, as applicable, or for procuring the commercial source material, delivery to site as well as spreading and light compaction as necessary.

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(b) Grassing or other vegetation cover:

"(i) Planting of grass sods..... Unit: m²

(ii) Hydroseeding..... Unit: m²

(iii) Trim, shape and roll verge..... Unit: m²

The tendered rate shall be irrespective of the number of applications required to obtain the required spread rate.

The tendered rate for grassing and vegetation shall cover the costs of preparing the area for grassing or vegetation cover as specified, procuring all materials, equipment, and labour, placing the product as specified by the suppliers specifications, including a 6 month maintenance period which includes watering weekly and ensuring a final cover rate of 90% of the total area vegetated."

Measurement for trim, shape and roll verge shall be the surface area of the verge prepared in accordance with the requirements of subclause 5.2.9. The rate tendered shall cover the cost of all things necessary to finish off the verge as specified, including the incorporation of material to make up for material lost due to weather or other reasons. (Cut and fill to bring verge to level payment under 8.3.4).

8.3.10 Gravel surface layer (Subclause 8.3.16)

Replace the contents of this Subclause with the following:

"The unit of measurement shall be the cubic metre of gravel surface layer and the quantity will be determined from the authorised dimensions of the compacted layer.

The tendered rate shall include full compensation for excavating the material as if in soft material, for loading and transporting the material for the free-haul distance, off-loading, spreading, breaking down, watering, mixing and compacting the material."

8.3.11 Provision of geofabric to be wrapped around the rockfill layer (New Subclause 8.3.17).....Unit : m2

The geofabric will be measured area based on the specified road width, the rockfill thickness of 300 mm and an overlap of 600 mm.

The rate shall cover the cost of the supply, delivery and laying of the geofabric. "

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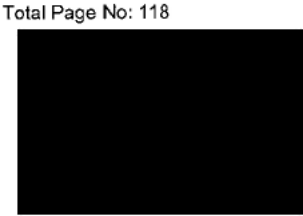
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1. SCOPE (CLAUSE 1)

No amendments.

2. INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (SUBCLAUSE 2.3)

2.1.1 General (Subclause 2.3(a))

Add the following under Subclause 2.3(a) "General":

"Construction joint:

A joint required on account of constraints or convenience in the method of construction.

Unforeseen joint:

A joint formed during concreting when plant failure, inclement weather, or some unforeseen event has enforced a halt in the placing of concrete and has thus created a situation in which a construction joint has to be made in a location that was neither designated nor approved before the commencement of concreting.

Extender:

Material which, when mixed with Portland cement, has a cementing property and is used as a portion of the cement in a concrete mix for economic reasons or for the chemical or physical properties (or both) that it gives to the concrete mix.

Cementitious binder:

Common cement that complies with the requirements of SANS 50197-1&2, and blends of certain types of common cement and cement extenders that comply with the requirements of SANS 55167-1&2, SANS 50450-1&2 and SANS 53263-1&2 where applicable.

Water/cement ratio:

Ratio (by mass) of the water to the cementitious binder in a concrete mix.

Immediate protection of concrete:

The prevention of moisture loss from the concrete from the time of compaction until full wet curing is possible.

Scabbling:

Removing all laitance and exposing the aggregate over 100% of the area using mechanized plant such as scabblers, abrasive blasters or other approved method.

Scabble:

Scabble shall be synonymous with scabbling.

2.2 EXPLANATION OF TERMS (SUBCLAUSE 2.4)

2.2.1 Strength concrete (Subclause 2.4.2)

Add the following:

"Grade 35 MPa/19mm means strength concrete Grade 35 MPa with 19mm stone."

2.2.2 Joints (Subclause 2.4.3)

Replace contents of this Subclause with the following:

"The location of joints is controlled by design requirements and construction limitations. "Designated joints" will only be those joints whose locations are shown on the drawings. The terms "constructional joints", "movement joints", "contraction joints" and "expansion joints" are used to identify various types of designated joints. All other joints required by the Contractor, including unforeseen joints as defined in 2.3(a) and those resulting from construction constraints, whether approved by the Employer's Agent or not, will not be considered as designated joints (i.e. they will be considered as "non-designated" joints). All non-designated joints (except for unforeseen joints) need to be approved by the Employer's Agent, in writing, before commencing with construction thereof."

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3. MATERIALS (CLAUSE 3)

3.1 CEMENT (SUBCLAUSE 3.2)

3.1.1 Alternative types of cement (Subclause 3.2.2)

Replace the contents of this Subclause with the following:

"Only CEM I 52.5 or CEM I 42.5 (Portland cements), CEM II A 52.5 or CEM II A 42.5 in accordance with SANS 50197-1 may be used. Further blending with a suitable extender shall be as per subclauses 5.5.1 and 5.5.11.

If the Contractor wishes to use any other type/blend of cement, he shall obtain the Employer's Agent's prior written approval. The tendered rates, however, shall be based on the use of the above-mentioned cements/blends only.

The test results conducted to evaluate the conformity of cement in terms of SANS 50197-1, Clause 9, shall be made available to the Employer's Agent at least 28 days before the materials are used for concrete."

3.1.2 Storage of cement (Subclause 3.2.3)

Add the following:

"Cementitious binder shall be used in the order in which it is received. Cementitious binder shall not be stored for longer than 8 weeks without the Employer's Agent's permission.

Any cementitious binder that shows signs of hydration, such as the formation of lumps, may not be used and is to be immediately removed from site."

3.2 WATER (SUBCLAUSE 3.3)

Add the following

"Where potable water is not used as mixing water for concrete, the water shall comply with BS EN1008:2002 *Mixing Water for Concrete*.

Final effluent shall not be used for curing concrete."

3.3 AGGREGATES (SUBCLAUSE 3.4)

3.3.1 Applicable specification (Subclause 3.4.1)

Add the following:

"The nominal stone size specified in the concrete grade (e.g. 35 MPa/26mm) shall mean stone conforming to the grading specified in SANS 1083 for the nearest equivalent size, i.e. 26mm means stone that complies with SANS 1083 for 28 mm size.

The fineness modulus of the sand delivered to the mixer shall lie between 1,7 and 2,8 and the standard deviation of fineness moduli of samples of sand that is delivered to the mixer during one shift shall be not more than 0,10."

3.3.2 Storage of aggregates (Subclause 3.4.3)

Add the following:

"When aggregates of different chloride content are stored on the Site, their use in the various classes of concrete shall be strictly controlled."

3.3.3 Types of coarse aggregates for watertight concrete (New Subclause 3.4.4)

In the Western Cape, coarse aggregates for watertight concrete shall be granites from a commercial source with a known low reactivity potential when reacting with free alkali in the cementitious binder.

3.3.4 Fine aggregates for watertight concrete (New Subclause 3.4.5)

Reference is made to "Fulton's Concrete Technology, Chapter 3, Aggregates for concrete".

Sands used for watertight concrete shall be well-graded, with wide variety of well-distributed particle sizes, to help in reducing water-demand for the mix while maintaining workability. The shape of the sand particles shall be as close to spherical as possible to aid in lubrication and ensure that inter-particle friction is reduced. For recommended grading of sands, refer to table 3.4 in Fulton's Ninth Edition Chapter 3.

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The Contractor shall provide the Employer's Agent with relevant results for the sand to be used in the concrete mix, such as grading curves and certificate stating the clay content.

All costs of the analyses/testing described above shall be deemed to be included in the cost of the rates for concrete.

3.4 ADMIXTURES (SUBCLAUSE 3.5)

3.4.1 Air-entraining agents (Subclause 3.5.2)

Replace the contents of this Subclause with the following:

"No air-entraining agents will be permitted."

3.5 REINFORCEMENT (SUBCLAUSE 3.6)

Add the following:

"All reinforcing steel shall have a certified post-consumer recycled content greater than 90% by mass."

3.6 WATERSTOPS (NEW SUBCLAUSE 3.9)

Waterstops shall be of approved manufacture and of the pattern and the material widths scheduled on the drawings. They shall conform to Specifications CKS 388 or 389, for natural rubber or PVC respectively.

All intersections between waterstops shall be prepared by mitring and welding/vulcanising intersection pieces in the factory in accordance with the manufacturer's instructions and to approval of the Employer's Agent. Only straight lengths of waterstop may be field welded, using appropriate jigs and tools.

Where required, waterstops shall have eyelets so that they may be tied securely to the adjacent reinforcement. "Rearguard"-type waterstops shall have flanges or cleats that grip effectively. Where the Contractor proposes alternative products/brands, the widths, profiles, flanges and cleats shall be equal to the specified products and are subject to the approval of the Employer's Agent.

Floor placed waterstops shall always be welded continuous to vertical wall waterstops at points of intersections.

3.7 JOINT FILLERS (NEW SUBCLAUSE 3.10)

Fillers for movement joints shall be closed cell expanded cross-linked polyethylene with properties equivalent to products manufactured by Sondor or equal approved for this purpose. The filler shall have the following minimum densities:

a) Water retaining / water excluding structures: 110kg/m^3

b) All other applications: 35kg/m^3

All fillers shall be pre-cut to suit the application with a tear out strip for forming the specified recess for the bondbreaker and sealant.

3.8 ALKALI-AGGREGATE REACTION (NEW SUBCLAUSE 3.11)

Reference is made to "Fulton's Concrete Technology, Ninth Edition, Chapter 10, Alkali-silica reaction."

Coarse aggregates for watertight concrete in the Western Cape shall be granites as per subclause 3.4.4. The following shall apply in other regions as well as to strength concrete with other coarse aggregates.

In accordance with this reference, the Contractor shall provide the Employer's Agent with the following (with the concrete mix design submission):

- Type of coarse aggregate
- Source of coarse aggregate
- Recent SANS 6245:2006 test results (accelerated mortar prism method) for the coarse aggregate
- Certificates from cement (and extender) supplier stating the certified active alkali content(s)
- Total active alkali content of the various mix designs, adhering to the maximum values stated below (including calculations)

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Result of SANS 6245 Coarse aggregate test (@12 days)	Description	Limit on total active alkali content of mix (kg/m³)
Linear Expansion < 0.10%	Aggregate innocuous	N/A
0.10% < Linear Expansion < 0.20%	Slowly reactive/ inconclusive	2.8
Linear expansion > 0.20%	Deleteriously reactive, rapidly expansive	2.1

Over and above the table above, aggregates from the Witwatersrand Supergroup shall have a limit of 2.0kg/m³ active alkalis in the mix design.

The Employer's Agent may instruct a petrographic analysis of the coarse aggregate for new/unknown coarse aggregates in addition to the tests above.

All costs of the testing described above shall be deemed included in the cost of the rates for concrete.

Note: The equivalent sodium oxide content is measured as $Na_2O + 0.658K_2O$. For cement it is expressed as a percentage by mass, for concrete it is expressed in kg/m³.

3.9 BOND BREAKERS, PRIMERS AND SEALANTS (NEW SUBCLAUSE 3.12)

The bond breaker shall be as specified on the drawings, but as a minimum requirement shall be self-adhesive PVC tape (or equal approved) with a width the same as the joint recess into which it is to be applied.

The primer, if required for the sealant, shall be fully compatible with the sealing compound that is to be used.

The elastomeric sealant shall be a one-component polyurethane liquid polymer base complying with the requirements set out in the relevant standards such as SANS 110 or the relevant replacement standard. The polymer shall be pouring grade for horizontal or near horizontal joints and gun grade for vertical/overhead joints and joints steeper than 1 in 10 to the horizontal. Sealants shall have a movement tolerance of 25%. Sealants shall have been tested to ensure that they are non-toxic and do not impart any odour or taste to, or otherwise taint, the water.

These sealants shall be suitable for indoor as well as outdoor applications and shall be UV resistant. The sealant shall be suitable for use at movements and connection joints in floors as well as for joints in contact with potable water. Sealant samples shall be timeously submitted for testing upon the request of the Employer's Agent.

Selected contraction and expansion joints will be waterproofed by an approved high performance tape/bandage placed over the joint as indicated on the drawings. This tape shall have a minimum thickness of 2mm and dimensions as indicated on the drawings. The tape shall be bonded to the concrete and covered with an approved epoxy-paste adhesive which is not sensitive to moisture.

This tape shall have the following typical properties:

- Suited for use in Potable water
- High water pressure resistance
- High Durability and chemical resistance
- UV- and weather resistant
- Root-Resistant
- Plasticizer free

3.10 JOINT PROTECTORS (NEW SUBCLAUSE 3.13)

Joint protectors shall be installed at specific locations for additional protection of floor slab joints as indicated on the drawings. Joint protectors shall consist of a HDPE strip as detailed on the relevant drawings.

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3.11 POLYETHYLENE SLIP SURFACE (NEW SUBCLAUSE 3.14)

Where specified on the drawings for the reservoir structure, the slip surface between the top of the mortar skim layer/no-fines layer and the underside of the floor slabs shall be 500 microns polyethylene sheet complying with SANS 952, with 200mm overlaps (taped) and perforated at 1000mm intervals in both directions.

4. PLANT (CLAUSE 4)

4.1 MIXING PLANT (SUBCLAUSE 4.3)

4.1.1 General requirements for mixing plant (Subclause 4.3.1)

Add the following:

"Standby mixers of adequate capacity and with an independent power unit shall be maintained on the site for immediate use in the event of breakdown of the regular mixers or failure of the power supply.

In addition, The Contractor shall have the following minimum plant available and in sound working order:

a) Two concrete mixers, each of sufficient capacity to complete a section of the wall between horizontal construction joints within 4 hours and without interruption.

b) Two weigh-batchers to supply the mixers.

c) Four concrete vibrators, at least one of which shall be powered by an internal combustion engine.

d) One air compressor.

e) Suitable and adequate Plant to transport and raise concrete and other material and equipment from ground level to the top of the structure at all stages of construction.

f) Elevated storage tanks of adequate capacity to ensure that sufficient water will be available before commencement of every major concrete-placing operation.

If the Plant used for placing concrete for the structure is electrically or mechanically powered, the Contractor shall also provide some other approved, non-electrically-powered standby means for placing concrete at an adequate rate in the event of a power or mechanical failure of the main Plant.

Should the Contractor elects to place a crane inside the walls of the structure during the construction period, he shall communicate with the Employer's Agent in good time to ensure that the design and layout of the panels that form the roof slab and floor allow for such positioning of the crane. Should sections of the roof and floor have to be redesigned to accommodate the crane, the redesign cost shall be borne by the Contractor."

4.2 FORMWORK (SUBCLAUSE 4.5)

4.2.1 Design (Subclause 4.5.1)

Add the following:

"In accordance with the Construction Regulations under Section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), the Contractor shall appoint a competent person to design, inspect and approve the erected temporary works on Site, inclusive of formwork and scaffolding. Written approval (signed-off) of the design, inspections and erection of the temporary works by competent person shall be submitted to the Employer's Agent for recordkeeping purposes throughout the various stages."

4.2.2 Finish (Subclause 4.5.2)

Add the following:

"All exposed concrete edges and external angles in concrete work shall have 20mm x 20mm chamfers unless otherwise specified or ordered, with the following exceptions:

a) edges to which bolt-on frames for grid flooring are to be fixed,

b) the sides of staircase risers,

c) and staircase treads.

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Edges to which bolt-on frames for grid flooring are to be fixed shall be finished neatly and uniformly with a rubbing stone to remove protrusions and slightly round the edge.

The sides of staircase risers (vertical edges) shall be edged with an 8mm round fillet (forming this round edge by neatly applying a silicone bead inside the shutters prior to casting is acceptable).

Staircase treads will, unless otherwise specified, be topped with a 25mm granolithic screed. The screed shall receive an 8mm round edge."

4.2.3 Ties (Subclause 4.5.3)

Add the following:

"No plugs, bolts, ties or clamps of any description used to hold the formwork will be allowed through the walls of water retaining structures, unless expressly approved by the Employer's Agent.

Only approved tie-rods consisting of solid rods (that remain embedded in the concrete) and with removable ends shall be used to hold the formwork of the walls. The removable tie-rod ends shall facilitate removal without damage to the concrete, and no permanently embedded parts of such tie-rods shall have less than 50 mm of cover to the finished concrete surface.

The cavities left in the concrete when the tie-rod end cones are removed shall be soundly caulked/ grouted up with a cement mortar to which an approved shrinkage-reducing agent has been added, and shall be neatly finished to a smooth surface uniform with that of the surrounding concrete.

The cost of supplying special tie-rods as well as the filling of cavities left by the tie-rod cones shall be included in the rates tendered for formwork under the appropriate pay items.

Under no circumstances shall formwork be secured to reinforcing bars."

4.2.4 Roof Infill Shuttering (New Subclause 4.5.4)

Shuttering will be required when casting roof infills between the hollow core slabs at the reservoir as shown on the drawings. The Contractor shall use his own method of shuttering upon agreement with the Employer's Agent. A degree of Accuracy II shall be required for the finish.

4.3 WATER-BATH (NEW SUBCLAUSE 4.6)

A temperature-controlled water-bath with a capacity to cure two hundred cubes shall be provided and maintained on site. The water-bath shall be located under cover.

5. CONSTRUCTION (CLAUSE 5)

5.1 REINFORCEMENT (SUBCLAUSE 5.1)

5.1.1 Fixing (Subclause 5.1.2)

Add the following:

"Welding of reinforcing steel will not be permitted.

The Contractor shall make provision for the Employer's Agent to inspect reinforcing once it has been fixed in place, with cover blocks secured and construction joints prepared. Formwork that prevents arm-length access to any reinforcing or construction joints for checking shall not be erected until the Employer's Agent is satisfied that preparations at that stage meet specification."

5.1.2 Cover (Subclause 5.1.3)

In Subclause 5.1.3(a) amend the words "or stirrup" *to read:* ", secondary reinforcement, tie, stirrup, tying-wire knots or wire ends".

Add the following:

"Tying wire may not encroach on the specified minimum cover by more than a single strand thickness.

The distance between pipes, ducts, conduits or sleeves in the concrete and the reinforcing steel shall nowhere be less than

- 40mm,
- 5mm plus the maximum size of the coarse aggregate, or

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[redacted]

- the cover specified on the drawings,

whichever is the largest.

The Contractor shall make provision for the Employer's Agent to inspect cover once all formwork has been erected and secured, joints prepared and items that are to be cast in are fixed in place. Where poor lighting between formwork prevents the Employer's Agent from adequately completing the inspection, the Contractor shall make available, for the Employer's Agent's use, a portable light (flashlight) of sufficient brightness to complete the inspection."

5.2 FORMWORK (SUBCLAUSE 5.2)

5.2.1 Classification of finishes (Subclause 5.2.1)

Replace the phrase "are classified as follows and will be so scheduled:" at the end of the first paragraph with the following:

"are classified below unless otherwise classified on the drawings, and will be so scheduled. In the case of a water-retaining tank / reservoir wall that is fully or partially buried, formwork for both formed concrete surfaces (backfill-side and water-side) shall be smooth. Everywhere else, except where otherwise specified, formwork for formed concrete surfaces against which backfill will be placed shall be rough and formwork for all other formed surfaces shall be smooth."

In Subclause 5.2.1(b) amend the words "to Degree of Accuracy II as defined in terms of Clause 6" *to read:* "to the Degree of Accuracy specified in 6.2".

(c) Special

Add the following:

"This finish is obtained by first giving the surface a smooth finish with the joints between formwork panels forming an approved regular pattern suitable for the appearance of the structure. All projections shall then be removed, irregularities repaired and the surface rubbed or otherwise treated until it is smooth with an even texture, appearance and colour.

If the finish of exposed surfaces does not comply with the requirements for uniformity of the texture and appearance, the Contractor shall, when instructed to do so by the Employer's Agent, rub down the exposed surfaces of the entire structure or any part thereof as specified below, entirely at his own cost. All repairs must be completed before the rubbing commences.

The surface shall be saturated with water for at least one hour. The initial rubbing of the face shall be carried out with a medium coarse carborundum stone together with a small amount of mortar of the same cement/sand ratio as the concrete being repaired. Rubbing shall continue until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. The paste produced by the rubbing shall be kept in place. The final rubbing shall be carried out with a fine carborundum stone and water. This rubbing shall continue until the entire surface has a smooth, even texture and is uniform in colour. The surface shall subsequently be washed with a brush to remove surplus paste and powder.

Special finishes shall be required on the sloped embankment floors of the reservoir where the slope is designated in the vicinity of 1:2.5. Special finishes shall be made to Degree of Accuracy II unless specified otherwise, and shall as a minimum requirement achieve a finish equivalent to that of smooth formwork. The finishes shall be obtained either by use of a sliding shutter or by alternative method agreed to with the Employer's Agent.

5.2.2 Preparation for formwork (Subclause 5.2.2)

Add the following:

"Construction joints shall be approved by the Employer's Agent."

5.2.3 Removal of formwork (Subclause 5.2.5)

Replace TABLE 2 in Subclause 5.2.5.2 with the following table:

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1	2	3	4	5	6	7	8	9	10
Formwork to Structural Member	Strength Class of Cement								
	CEM-1			CEM-II-A (or blend of CEM-I with **less** than 20% FA/GGCS /GGBS)			CEM-II-B, CEM-III (or blend of CEM-I and **more** than 20% FA/GGCS /GGBS)		
	Minimum time (24 hour periods) before removal of formwork								
	Weather								
	Hot or Normal	Cool	Cold	Hot or Normal	Cool	Cold	Hot or Normal	Cool	Cold
Beam sides, walls and unloaded columns	1	1.25	1.5	1.5	2	3	3	4	5
Slabs with props left underneath	2	3	4	4	5.5	7	6	8	10
Beam soffits with props left underneath and ribs with a ribbed floor construction	3	4	5	5	7	10	10	13.5	17
Slab props including cantilevers	5	7	9	10	13.5	17	10	13.5	17
Beam props including cantilevers	7	9.5	12	14	17.5	21	14	17.5	21

Add the following to the end of Subclause 5.2.5.3:

"This shall include evidence that curing and protection as per Subclause 5.5.8 is strictly adhered to."

Add the following to the end of Subclause 5.2.5:

"5.2.5.6 The Contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back propping of beams and slabs.

5.2.5.7 Where walls/beams have top slabs attached, the contractor shall keep the wall/beam propped until such a time as the top slab has attained its design strength. Back-propping of such structures shall be discussed and agreed with the Employer's Agent at the time of programme approval.

5.2.5.8 Any deviation from the table above or the agreed upon programme for back-propping, shall not be permitted without the Employer's Agent's acceptance in writing."

5.3 HOLES, CHASES AND FIXING BLOCKS (SUBCLAUSE 5.3)

Add the following:

"Cover blocks shall be made of mortar to achieve a strength class (and equivalent durability) of the concrete of the element they are placed in. They shall be placed at a spacing so as to avoid crushing from any applied construction and self-weight loads.

The holes or cavities left by ferrule heads in the concrete of water-retaining and water-excluding structures shall be filled with an approved non-shrink grout applied strictly in accordance with the manufacturer's specifications.

Plastic cover blocks will not be permitted in water-retaining and water-excluding structures."

5.4 PIPES AND CONDUITS (SUBCLAUSE 5.4)

Add the following:

"All pipes passing through concrete elements (floors, walls, slabs, etc.) shall be cast into the concrete elements simultaneously with the casting of the element. Openings for pipes shall only be left in concrete

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elements when so directed or approved by the Employer's Agent or when shown on the drawings. Pipes shall be installed in such openings in accordance with the details shown on the drawings."

5.5 CONCRETE (SUBCLAUSE 5.5)

5.5.1 Quality (Subclause 5.5.1)

5.5.1.1 Consistency (Subclause 5.5.1.2)

Replace this Subclause with the following:

"The slump, measured in accordance with SANS 5862-1, shall be within the limits given in the following table for both traditionally placed and pumped concrete:

Design Slump (mm), as per approved mix design	Tolerance (mm)
Slump ≤ 50	-10 to +15
50 < Slump < 75	-10 to +25
75 ≤ Slump ≤ 120	± 25

Design slump >120mm will be reviewed and approved/rejected at the discretion of the Employer's Agent. Concrete with slumps measured on site to higher than 145mm will not be accepted for conventional and pumped concrete mixes (unless pre-approved by the Employer's Agent).

For self-compacting concrete, acceptance based on slump will be at the discretion of the Employer's Agent but based on recommendations by the mix design suppliers."

5.5.1.2 Chloride content (Subclause 5.5.1.4)

Add the following to this Subclause:

"With reference to Table 4, efflorescence will not be acceptable on any exposed concrete surface."

5.5.1.3 Durability (Subclause 5.5.1.5)

Replace this Subclause with the following:

"The exposure conditions of the watertight concrete are classified as **"severe"**.

The maximum allowable water:binder ratio for watertight concrete shall be **0.50**.

The maximum allowable water:binder ratio for all other concrete of strength 25 MPa or greater shall be **0.60**."

5.5.1.4 Strength concrete (Subclause 5.5.1.7)

Add the following to this Subclause:

The concrete mixes shall be designed by an approved laboratory.

a) Design of concrete mixes:

The proportions of the various sizes of aggregate, binder and water shall be such as to produce a dense concrete of adequate workability for the particular circumstances under which the concrete will be transported, placed and compacted. Approved plasticizing additives may be used to ensure adequate workability in preference to varying the proportions of water and cementitious binder.

All exposed concrete shall be of the same colour. No change in materials or processes shall be made without the Contractor first satisfying the Employer's Agent that no change in colour will result.

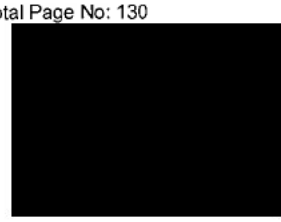
Where extenders are proposed by the Contractor for building surface beds and trafficable slabs, a maximum of 15% cement replacement with a suitable extender will be allowed.

b) Trial Mixes:

The Contractor shall for each class of concrete required for the Works, have trial mixes designed within the limits specified herein for 56 day, 28 day and 7 day strengths and he shall have cubes made and tested by an approved laboratory at his own expense. The test results of cubes made from trial mixes shall be used to determine the proportions for the "Designed Mixes" to be used in the Works.

Details of the mixes as designed shall in all cases be submitted to the Employer's Agent for approval, 30 days before concreting is carried out and no concrete shall be placed in structures before such approval in writing has been obtained. The proportions of cement, aggregates and water for each mix as approved shall not be changed except with approval of the Employer's Agent.

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The Employer's Agent must receive for any particular concrete mix:-

- Proportions of each design tested
- Strength of each cube tested
- Density of each cube tested
- The Contractor's nomination of the design he proposes."

5.5.2 Mixing (Subclause 5.5.3)

5.5.2.1 Ready-mixed concrete (Subclause 5.5.3.2)

Add the following to this Subclause:

"If the Contractor elects to use ready-mixed concrete in the Works he shall provide a qualified technical assistant who shall check the quality of materials used, the accuracy and effectiveness of the water gauges and all relevant parts of the batching and mixing equipment, the moisture content of the aggregates, the quantities batched, the time of departure of each batch and all other matters which may affect the quality of timely arrival of the concrete.

The technical assistant shall commence work at the batching plant sufficiently in advance of the batching of the first mix to carry out all the required checks and shall remain at the plant throughout the period in which concrete for the Works is being batched.

The technical assistant shall maintain a continuous record of all the tests and checks carried out by him. The record shall be available for the Employer's Agent's inspection at all times and a copy of the record for each day shall be given to the Employer's Agent the following morning."

5.5.3 Placing (Subclause 5.5.5)

Replace contents of this sub-clause with the following:

Concrete shall not be allowed to fall freely through a height of more than 3m unless otherwise approved by the Employer's Agent. In this case, approval shall be subject to the Contractor submitting a detailed method statement to the Employer's Agent. All costs included for casting to heights of more than 3m shall be deemed to be included in the tendered rates for concrete of the specific structure/wall element.

Add the following to the end of this Subclause:

"5.5.5.10 Concreting of circular walls (without vertical joints) between horizontal construction joints shall be carried out in both directions from a point on the wall in order to close the gap with fresh concrete.

5.5.5.11 Pumping of concrete shall not be permitted unless approved by the Employer's Agent. For such approval, the Employer's Agent will require 12-day accelerated shrinkage tests of the concrete to meet the criteria in subclause 5.5.11. The tendered rates for concrete will be deemed to include such testing costs.

5.5.5.12 Should excessive cracking of pumped-concrete occur, the Employer's Agent may instruct the Contractor to revert to conventionally placed concrete. All costs associated with changes in mix design, site placing equipment, and any remedial repairs to concrete will be at the Contractor's expense.

5.5.5.13 Structural concrete shall not be cast directly against the side of any excavation without the use of formwork unless prior approval has been obtained in writing from the Employer's Agent.

5.5.5.14 Concrete used in pipe trenches for encasement may be cast directly against the side of the excavation. Concrete for thrust/anchor blocks shall be cast directly against the side of the excavation."

5.5.5.15 Blinding layers shall be cast on the same day that earthworks excavations (Restricted as per Subclause 8.3.3 of SANS 1200 D and Extra excavation as per Subclause 8.3.5 of SANS 1200 D) have been completed."

5.5.4 Construction joints (Subclause 5.5.7)

Add the following to the beginning of this Subclause 5.5.7.1

"The position and pattern of all joints (designated or non-designated) shall be subject to the Employer's Agent's approval.

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The construction joints (designated or non-designated) in water-retaining and water-excluding structures shall be made strictly in accordance with the details shown on the drawings. Where alternative joint details are proposed by the Contractor, these are subject to the Employer's Agent's approval.

For construction joints at kickers, all additional costs for concrete, formwork preparation, etc. will be deemed to be included in the rates tendered for concrete in walls and formwork, respectively. Kickers shall be cast monolithically with the floor/slab concrete and the Contractor shall ensure that kickers are thoroughly compacted, immediately protected, and cured using suitable techniques, as specified.

Walls shall be cast in lifts of a height that permits each lift to be poured without interruption in one continuous operation during normal working hours.

It is the Contractor's responsibility to ensure that construction joints for water-retaining and water-excluding structures are watertight. The Contractor's proposed method for ensuring the watertightness of such joints shall be submitted to the Employer's Agent for his approval.

The joints between screeds and concrete floors shall be regarded as construction joints and the surface of the floor shall be prepared as described for construction joints."

For Subclause 5.5.7.3(b), replace the words "sand-blasted or chipped with a light hammer" *with the word* "scabbled".

5.5.5 Curing and protection (Subclause 5.5.8)

Add the following:

"Curing shall be conducted for a minimum of 7 days. The method of curing shall be approved by the Employer's Agent for the various elements.

Concrete will not be paid for unless immediately protected and properly cured and proof of curing is continuously visible on Site. The cost of immediate protection and curing shall be deemed to be included in the rates for concrete.

The Contractor is to pay special attention to both the immediate protection (see definition in subclause 2.3) and long term curing of the concrete for the various elements. Where deemed necessary by the Employer's Agent, the Contractor shall submit a Method Statement for approval outlining in detail the various measures that the Contractor will undertake to ensure effective immediate protection and long-term curing of the concrete.

Curing compounds will not be accepted as a stand-alone system for the immediate protection of concrete. Only resin-based curing compounds complying with ASTM C309 Type 1 or 2 Class B will be accepted where approved by the Employer's Agent.

Where accepted, the curing compound approved by the Employer's Agent shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, after a minimum of 48 hours of immediate protection. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Employer's Agent and rigidly applied by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape."

5.5.6 Adverse weather conditions (Subclause 5.5.9)

Add the following to Subclause 5.5.9.2:

"If concrete is to be cast during times of high ambient temperature or hot drying winds, the Contractor shall be responsible for taking the necessary steps to keep the placement temperature as low as possible. Such steps include the spraying of the coarse aggregate with water, the painting of silos with reflecting aluminium paint, the insulation of tanks and pipelines, and the protection of concrete ingredients against the direct rays of the sun. The area of the pour shall be shaded before and during concreting and the concrete shall be shaded from the time of mixing until eight hours after placing.

For the casting of the 300 ML reservoir structural roof topping, the Contractor shall be responsible for taking the necessary steps to ensure the area of pour is well sheltered / protected from the elements during and immediately after the pour. Such steps shall include but not be limited to the use of fog sprayers and windbreaks."

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[redacted]

5.5.7 Concrete surfaces (Subclause 5.5.10)

Add the following to Subclause 5.5.10.2:

"Under no circumstances shall cement mortar be added while floating concrete."

Add the following to the end of Subclause 5.5.10:

"5.5.10.4 Where the surfaces of the concrete are to be additionally hardened or protected, the positions of such surfaces and the method to be used will be shown on the drawings and will be scheduled. Materials or products with a ferrous content will not be allowed."

5.5.8 Watertight concrete (Subclause 5.5.11)

Add the following:

"The mix designs for watertight concrete must be aimed at ensuring concrete durability and must therefore be guided by the need to:

- Minimise the permeability of the concrete;
- Maximise the chemical resistance of the concrete to aggressive agents in the environment; and
- Reduce the heat of hydration and thermal gradient of thick sections (greater than 400mm thick) at early-age.

The following parameters shall be adhered to:

Parameter	Limit
Maximum shrinkage strain based on 12-day accelerated shrinkage test performed according to SANS 6085 specifications):	350 µm/m
Maximum water:binder ratio:	See 5.5.1.5
Minimum cementitious binder content:	300kg/m^3
Maximum cementitious binder content:	360kg/m^3
Maximum water content:	180kg/m^3
Maximum alkali content:	See 3.11
Maximum thermal coefficient of expansion for concrete:	10x10^{-6}/°C
Minimum coarse aggregate fraction (as a percentage of total (coarse + fine) aggregates):	0.55
Type of extender required:	Ground Granulated Blast-furnace Slag (GGBS), *OR* Fly Ash (FA)
Minimum and maximum range of extender replacement (as a percentage of total binder content)	40% - 50% (GGBS) 20% - 30% (FA)

Nominal coarse aggregates size for watertight concrete shall be 19mm or 26mm, as specified on the drawings or in the Bill of quantities. Nominal coarse aggregates can be blended with smaller size aggregates if required, and approved by the Employer's Agent. The Employer's Agent may request evidence (shrinkage testing, test panels, historic use of the specific concrete mix, etc.) indicating that the reduced aggregate size will not result in excessive shrinkage of the concrete.

If a pump mix is proposed by the Contractor for a watertight concrete application, it shall also meet the requirements of subclauses 5.5.5.11 and 5.5.5.12.

Where extenders are used/specified, Table 2 (as amended) shall apply, and the immediate protection during casting and the curing of concrete should be given special attention by the Contractor. Where extenders specified may not be locally available, the Contractor should take into account all the costs required to import and batch the specified extender in the rates for concrete (subclause 8.4.3).

The following structures / structural elements shall be considered water-retaining and shall be constructed using watertight concrete:

- Reservoir basin floors
- Reservoir embankment floors

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- Reservoir columns, column bases and column heads
- Reservoir crest walls footings
- Reservoir crest walls
- Reservoir internal access stairs and vehicle access ramp
- Reservoir spillway structure
- Reservoir inlet chambers
- Reservoir outlet chambers
- Stilling basin
- Reservoir bypass IV chamber
- Sand traps
- OSEC building sump
- Any other structure or element(s) of a structure retaining water

The following elements of structures shall be considered water-excluding and shall be constructed using watertight concrete:

- Reservoir galleries and gallery entrance structures
- Reservoir roof structural topping
- Raft foundations / base slabs below ground level
- Retaining walls fixed to raft foundations / base slabs
- Footings / thickenings in raft foundations / base slabs
- Pipeline chambers
- Any other structures or element(s) of a structure excluding water (including ground water assumed to be at top of final ground level)

5.5.9 Grouting (Subclause 5.5.13)

Add the following:

"Unless otherwise approved by the Employer's Agent, proprietary grouting materials shall be obtained ready-mixed in sealed pockets as supplied by the manufacturers."

5.5.10 Defects (Subclause 5.5.14)

Add to the end of Subclause 5.5.14.1:

"All defects shall be repaired as soon as possible after the formwork has been removed and the Employer's Agent has inspected the concrete. A statement of the method to be used for each repair shall be submitted to the Employer's Agent for his approval before any work is carried out. Such methods should deal separately with methods for the various depths of defects as follows:

a) Repair of shallow surface irregularities (e.g. blowholes or minor grout loss)

b) Repair of 5mm to 50mm deep irregularities with polymer modified repair mortars

c) Repair of deeper defects by means of formed micro-concretes

Each method should deal in detail with surface preparation, dealing with minimum product application depths (sawcutting and roughening of saw-cut edges etc.), the use of bonding agents and/or other proprietary product where specified by the applicator, product window periods and curing of the repair products.

The Employer's Agent may prohibit the further placing of concrete in the particular area concerned until he is satisfied that the repair has been satisfactorily executed."

5.5.11 Creating box-outs for and casting in of items (New Subclause 5.5.16)

a) Where an item (i.e. pipe, special, etc.) is to be cast/grouted into a concrete member/element at a later stage (such as for items supplied by others), the Contractor shall provide a box out hole in the

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concrete element. When constructing such holes, the reinforcement bars shall not be cut but shall run through the hole/opening.

Once the concrete element has been cast and the box out hole made, all formwork and boxing remaining in the holes shall be removed. Any alterations required to the position and shape of the holes shall then be made. This shall be followed by preparing the surface as specified in subclause 5.5.7.3(c), including thoroughly scabbling the sides of the holes to obtain a satisfactory surface to which the new concrete/grout will bind to.

b) When the item is ready to be cast in, the reinforcement shall then be cut (with the approval of the Employer's Agent) and/or bent out to suit the item being cast in. Cutting of reinforcing shall be kept to an absolute minimum. After positioning of the item, the remaining reinforcement shall be bent back in position (i.e. after flanges or similar protruding components have passed through the reinforcing). Cover of concrete over reinforcing as detailed in subclause 5.1.3 shall be adhered to, including cover between reinforcing and the item installed (unless otherwise directed or approved by the Employer's Agent).

c) The surface of the existing concrete shall be kept continuously wet for 24 hours before a layer of mortar slurry and the new concrete/grout are placed. Right before casting, all standing water shall be removed and the surface shall be covered with a layer of mortar slurry (or other approved method), as thick as practical, made of the same mix as the concrete in which the items are to be cast. Under no circumstances shall the mortar slurry be allowed to dry out prior to casting.

If watertightness is a requirement where the item is cast into the concrete element, the Contractor shall ensure watertightness by using an approved method (unless one is already specified by the Employer's Agent) such as tape wrapping the pipes or applying an approved swellable waterbar and profile around the pipe prior to casting in. The cost of such waterproofing method will be deemed to be included in the rates tendered for items scheduled under subclauses 8.7 and 8.13, as applicable.

Formwork shall be constructed and the item secured in position to prevent movement from the required position during casting. The Employer's Agent shall be called on to inspect the work for compliance at agreed milestones and, at minimum, while there is still sufficient access to inspect the work before the final formwork is positioned and casting commences.

The concrete/grout shall be mixed and placed as dry as possible to obtain a dense, watertight concrete. The concrete/grout shall be carefully worked around item, including the puddle flange (if any) and the pipe barrel or body of the special (as applicable), and shall be vibrated in layers so as to obviate a falling away from the item's (pipe / special etc.) surface of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass."

5.5.12 "No-fines" concrete (New Subclause 5.5.17)

A nominal aggregate size of 19mm shall be used in the manufacture of "no-fines" concrete. Each size of aggregate shall be a single size aggregate graded in accordance with SANS 1083.

The concrete shall be mixed in the following proportions:

Cement:	50 kg
Aggregate	:0,30m³
Water :	20 ℓ

Cement shall be measured by mass or in full pockets of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows. The aggregate shall be moist or wetted before the cement is added. Where drum mixers are used, about 20% of the water shall be poured into the drum before the aggregate and cement are loaded. The mixing time in the drum shall be about 45 to 50 seconds.

The quantity of water added shall be just sufficient to form a smooth grout which will adhere to and completely coat each and every particle of aggregate, and which is just wet enough to ensure that, at points of contact of aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 litres of water for every 50 kg of cement. Mixing shall be done in an approved batch-type mechanical mixer, but small quantities may be hand-mixed.

No-fines concrete shall be placed in accordance with the procedure approved by the Employer's Agent. It shall be placed in its final position, on an approved geotextile bidim, within 15 minutes of having been mixed. The concrete shall be worked sufficiently to ensure that it will completely fill the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping or ramming shall be avoided and under no circumstances shall the concrete be vibrated.

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All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:

- Retaining formwork in place
- Covering exposed surfaces with sacking or other approved material kept continuously wet
- Covering exposed surfaces with plastic sheeting

Between 24 h and 48 h after the no fines layer has been laid it shall be covered with a 1:4 cement:sand mortar skim layer 20mm thick. The mix shall be comparatively dry to ensure that it does not penetrate and block the cavities in the no-fines concrete. The surface shall be steel floated to form a plane surface.

The mortar skim shall be cured in the same manner as concrete for a period of not less than 2 days.

No wheel loads will be permitted on the no-fines layer unless approved by the Employer's Agent.

5.5.13 Precast paving slabs (New Subclause 5.5.18)

The paving slabs shall comply with the requirements of SANS 541, shall be as scheduled and with patterned surface, or equal approved. Samples of the types which the Contractor proposes to use shall be submitted for approval prior to construction.

The area to be paved shall be compacted to 95% of MAMDD (Mod AASHTO maximum dry density), trimmed and then treated with an approved weedkiller, with care being taken to avoid contaminating surrounding areas. The paving slabs shall be laid on a sand bed approximately 25mm thick, which shall be graded to the required levels and slopes as approved by the Employer's Agent.

The joints between the slabs shall be 2mm to 6mm wide and shall be grouted with cement mortar. Gaps in the pattern of slabs shall be filled with Grade 15 MPa/20mm concrete and given a wood floated finish.

5.5.14 Grouting in of equipment (New Subclause 5.5.19)

a) The Contractor shall form pockets to the details shown on the drawings to accommodate holding down bolts for equipment provided by the Contractor or by the Mechanical and Electrical Contractor. The holding down bolts will be provided and positioned by the Mechanical and Electrical Contractor for his equipment.

b) After casting of the concrete all shuttering shall be removed and the inside of the bolt holes and the surface on which any machine base is to be placed shall be cleaned and scabbled to remove all defective concrete, laitance, dirt, oil, grease and loose material.

c) Upon completion of the positioning and alignment of equipment (the Mechanical and Electrical Contractor will position his own equipment), and when instructed by the Employer's Agent, the Contractor shall in collaboration with the Mechanical and Electrical Contractor, grout up pockets and baseplates by filling pockets and voids under the baseplates with an approved non-shrink grout.

5.5.15 Backfilling of excess excavations (New Subclause 5.5.20)

Wherever the Contractor has over-excavated below the specified founding levels, such over-excavation shall be backfilled to bring the founding surface to the correct level by placing and compacting no-fines concrete or mass concrete of Grade 15 MPa/19mm, as directed by the Employer's Agent.

Backfilling with 5% cement stabilized sand compacted to 100% MOD AASHTO in 150mm layers may be appropriate for use under certain structures, if approved by the Employer's Agent. The cement stabilized sand shall be thoroughly mixed in the presence of the Employer's Agent.

5.5.16 Applied loads (New Subclause 5.5.21)

No loads (e.g. crushed stone or any other covering) shall be placed on the roof of the structure before the concrete has attained its design strength, unless approved supports are provided.

No wheel loads will be permitted over the 200mm thk reservoir floor panels.

Wheel loads that are excessive in the opinion of the Employer's Agent will not be permitted on the blinding / no-fines layers. Light pneumatic tyred vehicles may be permitted provided that the tyre inflation pressure does not exceed 250 kPa. Written approval shall be received by the Employer's Agent prior to applying any of these loads on the blinding/ no-fines layers.

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5.5.17 Soilcrete (New Subclause 5.5.22)

Soilcrete shall consist of an approved soil or gravel mixed with 5 % by mass of Portland Cement and only sufficient water to give it a consistency that will permit the soilcrete to be placed, using vibrators. The material used for soilcrete shall be sandy granular material of the following specifications:

Minimum Grading Modulus: 1.2

Maximum Plasticity Index: 10%

Maximum particle size: 38mm

Detrimental percentages of silt and clay shall be avoided

The soilcrete shall be mixed on site using suitable concrete mixers and the water and cement contents shall be carefully controlled. It shall be placed and thoroughly compacted by means of concrete vibrators so that all voids are filled.

5.5.18 Holding down bolts (New Subclause 5.5.23)

Where holding down bolts (HD bolts) are to be cast into concrete or grouted into pockets and where they are not specified and measured with the items they are fastening, these bolts shall be manufactured from stainless steel Grade 316L (unless otherwise specified), shall be fitted with insulating washers and shall have a nickel-based anti-seize compound applied along the full length of fastener threads before the nut is applied.

5.5.19 Sterilization of water-retaining structures (New Subclause 5.5.24)

In the case of the 300 ML reservoir, sterilisation shall take place prior to watertightness testing as set out in subclauses 7.4.1, 7.4.2 and 7.4.3. Watertightness testing shall be carried out as set out in subclause 7.2.5, taking note of necessary E Coli testing applicable to the reservoir structure.

Everywhere else, except where otherwise specified, before a water-retaining structure is sterilized, the structure shall have been tested for watertightness as set out in subclause 7.2.5, and the pipelines serving the structure shall have been sterilized. The inside of the structure shall then be thoroughly cleaned out and washed down with clean water. Thereafter the roof soffit, beams, columns and walls shall be thoroughly sprayed down, using pressurised equipment, and the floors shall be scrubbed with a calcium hypochlorite solution of concentration 0.15g/ℓ, as specified in Subclause 5.10 of SANS 1200 L.

On completion of the sterilization, the sterilizing solution shall be run to waste before the water-retaining structure is filled, except for the reservoir structure – refer to subclauses 7.4.1, 7.4.2 and 7.4.3.

Should additional work be required inside the structure after a watertightness test has been completed, the structure shall be resterilised at the Contractor's expense.

5.5.20 Granolithic and screeds (New Subclause 5.5.25)

Where the type of screed required is not stated, the screed shall comply with this granolithic screed specification unless it is applied to a conventional building roof top, in which case it shall comply with the roof screed specification in Specification PD.

5.5.20.1 Mix design

Only CEM I 52.5 or CEM I 42.5 (Portland cements), CEM II A 52.5 or CEM II A 42.5 in accordance with SANS 50197-1 may be used. Where extenders are proposed by the Contractor, a maximum of 15% fly ash, or 30% GGBS/GGCS will be allowed.

The maximum allowable water:binder ratio for granolithic screed shall be 0.50 and the minimum 28-day cube strength shall be 35MPa.

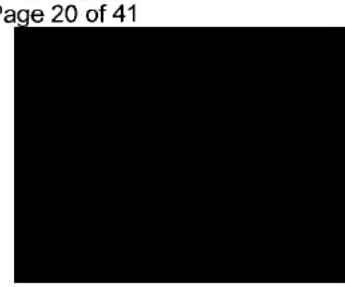
The coarse aggregate shall consist of granite or other approved aggregate. For screeds with a nominal thickness of up to 40mm, the coarse aggregate shall pass through a 10mm sieve but be retained on a 5mm sieve. For screeds with average thickness greater than 40mm, the nominal size of the coarse aggregate should be increased to one-quarter the thickness of the topping, subject to a maximum of 19mm.

The mix design must be submitted to the Employer's Agent for approval.

5.5.20.2 Preparation of base concrete

Before placing any granolithic screeds, the base concrete (substrate) shall be scabbled to remove all laitance and expose the aggregate over 100% of the area to be screeded using mechanized plant such as scabblers or abrasive blasters. After scabbling, the surface shall be thoroughly cleaned from dust and debris by

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scrubbing and/or high pressure wash, followed by soaking the surface with water for at least 24 hours. The Employer's Agent shall be called to inspect all prepared surfaces prior to placing the screed.

5.5.20.3 Placing

Remove all surface water and apply a 1:1 cement/clean sand grout with just enough water to provide the consistency of a slurry. The grout is to be vigorously brushed into the scabbled surface with brooms (which have bristles long and flexible enough to reach down into all the irregularities of the concrete surface).

On completion of brushing the grout into the scabbled surface, the surplus grout must be brushed off to leave only a thin grout coating (without pools of grout in depressions) and the screed must be placed while this grout coating is still visibly wet. Under no circumstances should the grout be allowed to dry out before placing the screed as this will cause debonding. This will typically require grouting over small areas at a time, just ahead of laying the screed.

Where a screed to fall is required but no fall (i.e. 1:100) is given for the area, the screed shall be laid to fall (slope) as indicated below.

- Where the screed only falls in one direction, the fall shall be 1:100.
- Where the screed consists of multiple sections sloping in various directions, the section(s) with the most gradual slope shall have a fall of 1:100. All other sections shall have slopes steeper than 1:100 to fall in the direction shown and tie into adjacent sections.

Where a screed is required and a fall is given for the area comprising of multiple sections sloping in various directions, the fall given shall be the minimum fall (fall for the most gradually sloped section) and some sections will require steeper falls to tie into adjacent sections.

Granolithic screeds applied to stairs shall be 25mm thick and level, unless otherwise indicated. The thickness of all other granolithic screeds shall be 30mm at the thinnest point (unless otherwise indicated).

The granolithic screed must be laid and compacted in one layer and care must be taken to obtain maximum compaction. All laitance on the surface of the fresh screed must be struck off prior to mechanical trowelling. Over-trowelling, causing an excessive cement-water paste to come to the surface, must be strictly avoided. Under no circumstances should cement or a dry cement-sand mixture be sprinkled directly onto the surface of a finish in order to absorb bleed water or laitance. Surface water should not be trowelled back into the finish and, similarly, water should not be applied between trowelling operations, since this may cause surface weakness.

The granolithic screed shall have exposed corners and edges rounded (r = 8mm), and shall be finished with a steel trowel to Degree of Accuracy I, or in the case of receiving a surface finish application, in strict accordance with the manufacturer's specification and approved by the Employer's Agent. Where granolithic screeds are applied to stairs, a portion of each tread shall be reeded (finished with a non-slip pattern) to the satisfaction of the Employer's Agent.

5.5.20.4 Curing

Granolithic screeds shall be protected from damage and cured in accordance with the requirements of subclause 5.5.8.

5.5.20.5 Joints

The granolithic screed shall be divided into panels with joints that align/coincide with joints in the base concrete (including joints at columns, walls, etc.). Additional joints are to be made in the screed if, when matching the base concrete joints, the screed panel size will exceed 9m^2. These additional joints shall be made such that joints are no more than 3m apart, equally spaced and the length:width ratio of the panels adheres to a 1,5:1 limit. The Contractor shall have his proposed additional joint locations approved by the Employer's Agent prior to commencing with the screeding work.

Unless detailed otherwise, screed joints that align with the base concrete joints shall be full-depth and of the same width as those in the base concrete. Joints that do not align with the base concrete joints shall be formed by cutting grooves 3mm wide by 25mm deep into the screed within 8 hours of placing the screed and sealed as specified on the drawings.

All joints shall be straight, neat and of workmanlike appearance. All joints shall be sealed as shown on the drawings.

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When placing granolithic screed against an adjacent band of granolithic screed, the edge of the latter shall be prepared by wire brushing and brushing with grout. Under no circumstances shall the brushed grout be allowed to dry out prior to placing screed.

5.5.20.6 General

Screeds found to be delaminating shall not be accepted.

The interface between the screed and substrate, if visible (i.e. sides of walkways or stairs that have received a screed and do not abut the structure), shall be finished flush and made neat either by rubbing down or by another suitable method approved by the Employer's Agent. Fairing coats are not acceptable.

5.5.21 Concrete protection and proprietary floor finishes (New Subclause 5.5.26)

Concrete protection and proprietary floor finishing products shall be applied where specified on the drawings or in the Bill of Quantities. The Contractor shall ensure that the substrate and preparation thereof meet the requirements of the product being applied (if applicable), and the Employer's Agent shall be called to inspect all prepared substrates prior to applying/installing the finish. A trial panel (including skirting if applicable) shall be prepared in advance by the Contractor for the Employer's Agent's approval.

All installations of proprietary products shall be carried out by supplier-approved applicators and in strict accordance with the manufacturer's specifications. The finish (including joints) shall be level, plum, uniform, straight and of a neat and workmanlike appearance. The supplier's technical representative shall carry out regular inspections to ensure that their specifications are adhered to during installation. Any thicknesses specified shall be the dry film thickness. Although some of the more common finishes are specified below, other finishes may be specified elsewhere.

Where aluminium straight edge trim (flooring trim) is specified as a stop end for the finish, the underside of the trim shall be lightly sanded, and the entire underside adhered securely to the substrate with Sikadur-30 (or similar approved) epoxy paste prior to applying the finishing products. The finishing products shall be applied over the appropriate section of the aluminium trim and worked into holes in that section provided for the product to bond to. The exposed edges of the aluminium trim shall be masked and protected during construction and shall have a clean and 'new' appearance once construction is complete. Any visible gaps between the aluminium trim and the substrate to which it is affixed due to undulations in the substrate shall be filled with Sikafloor-161 (or equal approved epoxy primer and mortar) and neatly finished.

a) Epoxy Finish:

Unless otherwise indicated, epoxy finishes for an area are to be applied after completing the Works in that area.

Epoxy finishes shall be completed in strict accordance with the manufacturer's method statements and product data sheet instructions. Although Sika products are specified below, equal approved alternatives may be approved by the Employer's Agent. A 10-year guarantee shall be given, in writing, on epoxy finishes.

Prior to applying finishes, edges and trim shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the epoxy finish and sealed with Sikaflex Pro-3 or equal approved. If day joints are required and unavoidable, the Contractor shall have his proposed joint locations approved by the Employer's Agent prior to commencing with work.

Unless otherwise indicated, where epoxy finishes abut other elements, where they cross over elements\interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 (or equal approved) at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

Type 1: Epoxy-cement seal finish:

The epoxy-cement seal finish shall consist of a 2mm thick layer of Sikagard 720 EpoCem or equal approved. Where a thicker layer is specified, each coat will not exceed 2mm thickness.

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Type 2: Epoxy chemical resistant finish:

The epoxy chemical resistant finish shall consist of 2x brushed coats of Sikagard 720 Epocem or equal approved (as a primer) and least 2x coats of Sikagard-63N or equal approved (min. 0.25mm thick).

Type 3: Epoxy finish:

The epoxy finish shall consist of 2x brushed coats of Sikafloor-161 or equal approved (for priming and to provide a levelled surface) followed by a 3mm thick (min.) Sikafloor-263 SL ZA or equal approved wearing course (combined with Sikafloor Quartsand SS2 or equal approved). The finished colour shall be RAL 7038 unless otherwise indicated. All edges of the floor finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equal approved), installed in accordance with the specification provided at the start of this Subclause.

Type 4: Epoxy broadcast finish:

The epoxy floor broadcast finish shall be at minimum 4mm thick and shall consist of 1-2 brushed coats of Sikafloor-161 or equal approved (for priming and to provide a levelled surface), followed by a Sikafloor-263 SL ZA or equal approved base coat (combined with Sikafloor Quartsand SS2 or equal approved), followed by a broadcast layer of 0.4-0.7mm quartz sand and finished with a Sikafloor-264 ZA or equal approved seal coat. The finished colour shall be RAL 7038 unless otherwise indicated. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equal approved), installed in accordance with the specification provided at the start of this Subclause.

Type 5: Epoxy cove skirting:

The epoxy cove skirting shall have a 25mm radius cove and be 100mm high. The top edge shall be neatly finished with a 6mm aluminium straight edge trim (Kirk ASE060 or equal approved) as a stop end.

The skirting shall be formed with Sikafloor-161 or equal approved mortar bulked up with clean sand and overcoated with Sikafloor-263 SL ZA or Sikafloor-264 ZA or equal approved (as applicable to match the adjacent finish type and colour). The interface between the floor and the cove skirting shall be seamless.

The thickness of the completed cove skirting shall be 7mm at the top edge and at least 4mm at the bottom edge, and the bottom of the skirting shall tie in level with the finished floor (they shall meet without a step). This will require the concrete substrate near the bottom edge of the cove to be cut back slightly (no more than 5mm) before constructing the cove.

Any gaps between the substrate and aluminium trim due to the substrate not having a flat surface shall be filled with an approved mortar and finished to match the finish of the wall (not to be finished to appear similar to the aluminium trim).

Type 6: Epoxy seal coat finish:

The epoxy seal coat finish shall consist of 1x brushed coat of Sikafloor Garage or equal approved (as a primer) and at least 2x seal coats of Sikafloor Garage or equal approved. The finished colour shall be RAL 7035 unless otherwise indicated. Sikafloor-161 or equal approved repair mortar and primer shall be used to repair any minor damages to the substrate prior to applying the seal coat finish.

Type 7: Epoxy roller coat finish:

The epoxy roller coat finish shall consist of 1x brushed coat of Sikafloor Garage or equal approved (as a primer) and at least 2x seal coats of Sikafloor-264 ZA or equal approved. The finished colour shall be RAL 7038 unless otherwise indicated. For coating vertical surfaces, Sika Extender T or equal approved shall be added to the seal coats.

Type 8: Epoxy non-slip roller coat finish:

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c) **Quartz-encapsulated Resin Finish:**

Unless otherwise indicated, quartz-encapsulated resin finishes for an area are to be applied after completing the Works in that area. The finished colour shall be light grey unless otherwise indicated.

Quartz-encapsulated resin finishes shall be completed in strict accordance with the manufacturer's method statements and product data sheet instructions. Although Flowcrete and Sika products are specified below, equal approved alternatives may be approved by the Employer's Agent. A 10-year guarantee shall be given, in writing, on quartz-encapsulated resin finishes.

Prior to applying finishes, edges and trim shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the resin finish and sealed with Sikaflex Pro-3 or equal approved. If day joints are required and unavoidable, the Contractor shall have his proposed joint locations approved by the Employer's Agent prior to commencing with work.

Unless otherwise indicated, where quartz-encapsulated resin finishes abut other elements, where they cross over elements\interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

Type 1: Quartz-encapsulated resin finish:

The quartz-encapsulated resin finish shall be a 4mm thick Flowcrete Peran STB system or equal approved with a power floated finish, and shall consist of various layers specified by the manufacturer including Flowprime, Scatter 3, Peran STB Slurry, STB Coloured Quartz, Peran STB Sealcoat and UV resistant Super Satin Sealer.

All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equal approved), installed in accordance with the specification provided at the start of this Subclause.

Type 2: Quartz-encapsulated resin cove skirting:

The quartz-encapsulated resin cove skirting shall be Flowcrete Peran STB cove skirting or equal approved to match the adjacent flooring system. The interface between the floor and cove shall be seamless.

The skirting shall have a 25mm radius cove and be 100mm high. The top edge shall be neatly finished with a 6mm aluminium straight edge trim (Kirk ASE060 or equal approved) as a stop end.

The skirting shall comprise of Flowtex F1 Coving resin (natural) or equal approved as a primer, followed by forming the cove with Flowtex F1 coving resin mixed with STB Coloured Quartz or equal approved. The coving shall then be completed with topcoats and seal coats as recommended by the floor finish manufacturer such that the skirting matches the adjacent Flowcrete Peran STB system floor or equal approved.

The thickness of the completed cove skirting shall be 7mm at the top edge and 4mm at the bottom edge, and the bottom of the skirting shall tie in level with the finished floor (they shall meet without a step). If required by the manufacturer, the concrete substrate near the bottom edge of the cove shall be cut back slightly (no more than 5mm) before constructing the cove to ensure the minimum required thickness is maintained.

Any gaps between the substrate and aluminium trim due to the substrate not having a flat surface shall be filled with an approved mortar and finished to match the finish of the wall (not to be finished to appear similar to the aluminium trim).

d) HDPE anchor-knob sheeting:

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[redacted]

The epoxy non-slip roller coat finish shall consist of 1x brushed coat of Sikafloor Garage or equal approved (as a primer) and 1x coat of Sikafloor-264 ZA or equal approved with Sika Extender T or equal approved and 0.1-0.5mm quartz sand. The finished colour shall be RAL 7038 unless otherwise indicated.

b) Polyurethane Finish:

Unless otherwise indicated, polyurethan finishes for an area are to be applied after completing the Civil Works but before commencing with M&E Works for that area.

Polyurethane finishes shall be completed in accordance with the manufacturer's method statements and product data sheet instructions. The polyurethane finish shall also include retaining/anchor groove openings (along joints, around openings and around the perimeter of all application areas to prevent curling or lifting of the products), and free edge grooves (for terminating the products so as to maintain the minimum product thickness as the product cannot be feathered at the edges).

Although Sika products are specified, equal approved alternatives may be approved. The finished colour shall be RAL 7037 unless otherwise indicated.

Prior to applying finishes, edges shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the polyurethane finish. Joints shall be sealed with Sikaflex Pro-3 or equal approved. Additional joints through the polyurethane finish shall be incorporated when necessary to ensure that any area of polyurethane finish enclosed by expansion joints does not exceed 16m^2. The Contractor shall have the locations of these additional joints approved by the Employer's Agent prior to commencing with work.

Unless otherwise indicated, where polyurethane finishes abut other elements, where they cross over elements\interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 or equal approved at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

A 10-year guarantee shall be given, in writing, on polyurethane finishes.

Type 1: Polyurethane cement textured finish:

The polyurethane cement textured finish shall consist of a 6mm thick (min.) layer of Sikafloor-20 PurCem or equal approved. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 6mm aluminium straight edge trim (Kirk ASE060 or equal approved), installed in accordance with the specification provided at the start of this Subclause.

Type 2: Polyurethane cement smooth finish:

The polyurethane cement smooth finish shall consist of 1.5mm (min.) scratch coat of Sikafloor-21 PurCem or equal approved followed by a 4.5mm thick (min.) layer of Sikafloor-21 PurCem or equal approved. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 6mm aluminium straight edge trim (Kirk ASE060 or equal approved), installed in accordance with the specification provided at the start of this Subclause.

Type 3: Polyurethane cement cove skirting:

The polyurethane cement cove skirting shall have a 25mm radius cover and be 100mm high with the top edge finished neatly at a right angle. The skirting shall be formed with Sikafloor-29 PurCem or equal approved detailing mortar overcoated with 2 layers of Sikafloor-31 PurCem or equal approved. The thickness of the completed cove skirting at the top and bottom edge shall match the thickness of the abutting floor finish, with the cove being thicker. The bottom of the finished cove shall tie in level with the finished floor (they shall meet without a step). Unless otherwise indicated, the interface between the top edge of the skirting and the substrate shall be neatly finished and fully sealed by applying a bead of Sikaflex Pro-3 or equal approved.

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A protective lining to soffit and walls shall be manufactured from 3mm thick HDPE with anchor knobs which will be cast into concrete. The HDPE anchor-knob sheeting shall be fit-for-purpose with a proven history in the environment into which it is to be placed. The lining shall be sealed or fusion welded to be watertight at all joints in strict accordance with the manufacturer's specifications. A trial panel shall be prepared by the Contractor for Employer's Agent's approval.

e) Calcium Aluminate Cement lining:

A Calcium Aluminate Cement lining is to be applied to the concrete surface post-cast (or to existing concrete), in strict accordance with the manufacturer's specifications. A trial panel shall be prepared by the Contractor for Employer's Agent's approval.

5.5.22 Microbial Protective Admixture (New subclause 5.5.27)

Where specified on the drawings and in the Bill of Quantities, the concrete mix shall be designed with the inclusion of a microbial protective admixture (Penetron BIOMIC, Xypex Bio-San C500 or equal approved) to provide protection against biogenic acid attack and subsequent concrete spalling and rebar corrosion in highly corrosive environments. Quantity of admixture to be batched in the concrete mix will be as per manufacturer's recommendations.

5.5.23 Construction of weir crests (New Subclause 5.5.28)

Weir crests shall be constructed to the tolerances provided in subclause 6.2.1 and finished surfaces shall have a smooth finish. Rounded/chamfered/flat weir crests shall be constructed monolithically with the final wall cast (i.e. from the below designated joint level, or approved non-designated joint level, up to top of concrete weir level). Contractor shall, prior to casting, provide a method statement for construction of each weir type for approval by the Employer's Agent. Creating the weir profile with a cement mortar (or any other proprietary product) will not be accepted, nor will delamination of the concrete surface be accepted.

6. TOLERANCES (CLAUSE 6)

6.1 PERMISSIBLE DEVIATIONS (SUBCLAUSE 6.2)

6.1.1 General (Subclause 6.2.1)

Replace the last sentence of this Subclause with the following:

"If no degree of accuracy is specified, the following shall apply:

Degree of Accuracy I shall apply to the following structures/components of the Works (including installation tolerances on precast members installation), as well as further accuracy requirement where so stated:

a) Top of weirs, including all weir crest surfaces

b) All column heads above reservoir columns. Levels and centre-points of top of column heads shall be surveyed and results submitted to the Employer's Agent for approval to confirm tolerances are within specified limits prior to erection / installation of precast prestressed beams.

Degree of Accuracy II shall apply to all other structures/components of the Works, unless specified otherwise on the drawings.

Every specified permissible deviation is binding in itself. The cumulative effect of permissible deviations will not be considered. The maximum permissible vertical deviation is subject to the other permissible deviations."

6.1.2 Specified PDs (Subclause 6.2.3)

Replace Subclause 6.2.3(a)(3) with the following:

Permissible deviation
Degree of accuracy

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	III	II	I
	mm	mm	mm
"Cover to reinforcement (see (e) below)	-0+10	-0+10	-0+10

"

Replace Subclause 6.2.3(d)(5) with the following:

	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
"Verticality, per metre of height.....	5	3	2
subject to a maximum of	50	30	10

"

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7. TESTS (CLAUSE 7)

7.1 FACILITIES AND FREQUENCY OF SAMPLING (SUBCLAUSE 7.1)

7.1.1 Facilities (Subclause 7.1.1)

Add the following:

"Site sampling methods storage shall be in accordance with SANS 5861-3:2006.

The cost of all testing, including the cost of sampling, storage and transport of samples shall be included in the rates tendered for concrete work."

7.1.2 Frequency of sampling (Subclause 7.1.2)

Add the following to Subclause 7.1.2.1:

"One sample shall consist of three concrete test cubes.

For each sample taken the position in the structure shall be recorded where the batch represented by that sample is placed."

7.2 TESTING (SUBCLAUSE 7.2)

7.2.1 Watertightness test (New Subclause 7.2.5)

7.2.1.1 General

The Works will not be certified Practically Complete until the structures and concrete roofs have been proved by testing to be watertight to the satisfaction of the Employer's Agent and the structures have been sterilised. If required by the Employer's Agent, the structure shall be retested during and before the expiry of the Defects Liability Period.

7.2.1.2 300 ML Reservoir

Watertightness testing shall be undertaken on all water-retaining structures, with each component tested independently of adjacent components. i.e. if two water-retaining components share a wall, then they shall not be watertightness tested at the same time.

Any openings in the structure, including those allowed for equipment to be provided at a later stage by the Mechanical and Electrical Contractor, shall be fitted with temporary watertight closures. The closures shall be fabricated from steel plate of thickness determined by the Contractor, but with a minimum of 5mm. The closures shall be provided with suitable seals and shall be held in place by props or anchor bolts.

It is envisaged that, due to the volume of water needed for the watertightness testing of the 300 ML reservoir, the Contractor will use potable water from the incoming pipeline to fill the reservoir, provided that the filling rate does not exceed the rate specified below of 2,0m every 24 hours.

The structure shall be filled with water at a uniform rate not exceeding 2,0m in 24 hours until the top water level has been reached. The top water level is stated on the drawings and if unclear, should be provided by the Employer's Agent. Structures should not be allowed to overtop/overflow. The water level will then be carefully noted and recorded by the Employer's Agent in relation to a fixed benchmark and shall be maintained by the addition of further water for a stabilizing period to permit complete absorption of water by the concrete.

The stabilizing period shall be 21 days. After the stabilizing period, the level of the liquid surface shall be recorded at 24-hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation, shall not exceed 1/500th of the average water depth of the full tank, or 10mm, whichever is less.

If and where applicable, the evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

In the event of appreciable leakage being evident at any stage of the filling or testing or in the event of the Employer's Agent considering the final degree of watertightness to be unsatisfactory, the Contractor when ordered by the Employer's Agent shall discontinue such filling or testing and shall, at his own expense, take approved steps immediately to rectify the leakage, until a satisfactory test is obtained, which shall prove to

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the Employer's Agent that a sufficient degree of watertightness has been obtained. In the event that this requires partial / full draining of the reservoir structure, water volume will be drained by downstream demand after water quality has been tested and confirmed safe for downstream demand as outlined further on in subclause 7.2.5. All associated costs of re-testing of the reservoir structure etc. shall be borne by the Contractor.

It is envisaged that, due to the size of the 300 ML Reservoir Structure and the volume of water needed, the watertightness testing will take place during the first filling of the reservoir: Prior to filling the reservoir for watertightness testing, the entire inside surface of the reservoir including columns and roof shall be thoroughly hosed down with chlorinated water and brushed until properly cleaned of all dirt and other foreign matter, in accordance with subclause 7.4.1.

Upon successful completion of the watertightness testing of the 300 ML Reservoir Structure, the Contractor shall conduct testing to establish whether the water is safe for release into the bulk water system. The following parameters shall be measured to confirm that the reservoir has been properly disinfected and that the water is safe for release into the bulk system;

- E.Coli
- Faecal coliforms
- Heterotrophic Plate Count
- Total coliforms

The water will only be considered safe for release/distribution into the bulk system if the above are not detected. If any of the above are detected the Contractor is referred to subclause 7.4.2 for further action.

Procedures and methods for testing shall be as follows:

- Water samples shall be taken at water depths of 0.3m (2.3% of FSL), 6.3m (51.1% of FSL) and 12m (96.6% of FSL) for a total of 27 samples at the following points:
    - Four corners of the reservoir basin floor (flat portion of floor) – 12 samples. Gridline references 4E, 4U, 12E, 12U.
    - Four points within the basin floor footprint of the reservoir – 12 samples. Gridline references 6H, 6P, 10H, 10P.
    - One point at the centre of the reservoir basin – 3 samples. Gridline reference 8M.

Testing of the water samples shall be undertaken by a SANAS accredited laboratory in terms of ISO/IEC 17025:2017.

The first filling of the reservoir may only commence once the Licence to Impound has been issued by the Department of Water and Sanitation: Dam Safety Office.

7.2.1.3 All other water-retaining Structures

Watertightness testing shall be undertaken on all water-retaining structures, with each component tested independently of adjacent components. i.e. if two water-retaining components share a wall then they shall not be watertightness tested at the same time.

Any openings in the structure, including those allowed for equipment to be provided at a later stage by the Mechanical and Electrical Contractor, shall be fitted with temporary watertight closures. The closures shall be fabricated from steel plate of thickness determined by the Contractor, but with a minimum of 5mm. The closures shall be provided with suitable seals and shall be held in place by props or anchor bolts.

For all other structures, should water from the incoming pipeline not be able to be used, potable water used for watertightness testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures. Tendered rates are to include the supply and use of potable water.

The structures that will require watertightness testing include:

- Stormwater Collection Chambers / Manholes on reservoir footprint
- Stormwater Collection Channels around reservoir perimeter
- OSEC Building Sump

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- Any other water-retaining structures retaining water internally

Should earth-backfilling of the structure be required, watertightness testing shall be conducted prior to backfilling to facilitate the detection of leaks, unless otherwise approved by the Employer's Agent.

The structure shall be filled with water at a uniform rate not exceeding 2,0m in 24 hours until the top water level has been reached. The top water level is stated on the drawings and if unclear, should be provided by the Employer's Agent. Structures should not be allowed to overtop/overflow. The water level will then be carefully noted and recorded by the Employer's Agent in relation to a fixed benchmark and shall be maintained by the addition of further water for a stabilizing period to permit complete absorption of water by the concrete.

The stabilizing period should be 21 days. After the stabilizing period, the level of the liquid surface shall be recorded at 24-hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation, shall not exceed 1/500th of the average water depth of the full tank, or 10mm, whichever is less.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

In the event of appreciable leakage being evident at any stage of the filling or testing or in the event of the Employer's Agent considering the final degree of watertightness to be unsatisfactory, the Contractor when ordered by the Employer's Agent shall discontinue such filling or testing and shall, at his own expense, take approved steps immediately to rectify the leakage, until a satisfactory test is obtained, which shall prove to the Employer's Agent that a sufficient degree of watertightness has been obtained.

All associated costs of retesting the structure for watertightness (including re-filling of the structure) shall be borne by the Contractor.

The Contractor shall empty the structure once the structure has passed the watertightness test. On successful completion of the watertightness test, the Contractor shall remove the temporary watertight closures, along with any anchor bolts, and shall grout the holes allowed for the anchor bolts with a non-shrink grout approved by the Employer's Agent.

The costs of emptying a water-retaining structure which cannot be drained shall be borne by the Contractor. The water shall be discharged in a manner approved by the Employer's Agent and shall be such that the employer can utilize the water if he so desires. The water shall not be used as a medium for additives to effect remedial work or to stop leaks.

7.2.1.4 Concrete roofs

The roof of the 300 ML Reservoir Structure shall be tested by the application of water to the outside of the roof structure by means of a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 hours. No leaks or damp patches shall be allowed to show on the roof underside i.e., inside the reservoir during the test or after the test has been carried out for up to 3 hours after the hose/sprinkler system has been turned off. The roof of the 300 ML reservoir shall be tested for watertightness before initial filling of the reservoir takes place so that visible confirmation of damp patches on the roof underside can be made.

All other concrete roofs (whether receiving a waterproof finish or constructed from watertight concrete) shall be watertightness tested. Testing shall be done after applying the waterproof finish (if applicable) by ponding the roof with at least 25mm of water for 24 hours. For domed or sloped slabs where ponding is not practical, each section of the roof shall be continuously hosed or irrigated using a sprinkler system whereby every part of the rooftop remains drenched for 24 hours. The slab or roof will be considered satisfactory if no leaks or damp patches are visible from the underside during or following the tests.

7.2.2 Grouting tests (New Subclause 7.2.6)

The Contractor shall, where so ordered, carry out a site test for each grouting procedure and each grouting gang to be used. The tests shall be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding 1m^2 in an area unless otherwise ordered. When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80% with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95%. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Employer's Agent.

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The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and also subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of subclause 7.2.1 to 7.2.3.

7.2.3 Durability Testing (New Subclause 7.2.7)

Concrete shall comply with the durability parameters defined below:

a) Water Sorptivity

Sorptivity is sensitive to surface effects and may be used to assess the effectiveness of initial curing/immediate protection practices on concrete.

b) Oxygen Permeability

Permeability may be used to assess the overall micro and macrostructure of the concrete since it is particularly sensitive to macro-defects such as voids and cracks in the cover zone which act as short-circuits for permeating gases. It can therefore also be a useful means of assessing the degree of compaction in concrete, presence of bleed voids and channels and degree of interconnectedness of the pore structure.

Permeability shall be tested in a manner approved by the Employer's Agent.

c) Concrete Cover

Cover concrete is the outer concrete layer which protects the internal reinforcing stee and its depth varies according to the requirements of different classes of exposure, as well as the designer's selection of tolerance margins that take into account level of workmanship on site, quality control procedures and consequences of low/high cover on structural design.

Test for cover shall be conducted using an approved non-destructive calibrated electromagnetic cover meter.

Testing shall be conducted on the reservoir structure when instructed by the Employer's Agent to confirm that the specified depth of concrete cover has been achieved. The cover meter tests shall cover at least 1m² for every 50m² exposed. The cover meter must be calibrated for each project by drilling and measuring actual cover in at least 3 locations to validate the readings. Payment for repair of areas where drilling has occurred to confirm concrete cover and cover meter calibration is catered for by clause 8.7.

Minimum cover to reinforcing for all other structures shall be as indicated on the reinforcement drawings.

7.3 ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE (SUBCLAUSE 7.3)

Add the following:

"Test results obtained from the supplier of ready-mixed concrete will not be accepted for evaluation in terms of 7.3, but samples for testing shall be taken of such concrete at the point of placing."

Add the following new subclauses:

7.3.1 Durability Index Tests (New Subclause 7.3.6)

"Reference is made to the following literature and Standards:

- Fulton's Concrete Technology, Chapter 9, Durability of Concrete.
- Durability Index Testing Manual Version 2.0, May 2010.
- SANS 3001-CO3-1: Concrete durability index testing – Preparation of test specimens,
- SANS 3001-CO3-02: Concrete durability index testing – Concrete durability index testing – Oxygen permeability test.

Concrete used for the reservoir structure shall be subject to Durability Index Testing for the purposes of quality control on site and ensure adequate durability of the final concrete on site in accordance with its function and exposure environment.

The testing shall be carried out using test panels of dimensions of 600mm long x 600mm wide x 200mm thick which are to be placed, constructed, and cured in the same manner as used in the reservoir structure. Test samples shall be cored from the face of the test panel that mimics the cast face of its intended use in the reservoir structure after a period of between 28 and 35 days after casting. The coring from each test panel shall exclude the outer 100mm along the perimeter. Samples shall represent the near-surface properties of concrete and shall be typically obtained from the depth range of 5mm to 35mm from the formed face. Interior

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concrete obtained from a depth greater than 40mm from the formed face shall not be utilised for concrete durability indexing purposes.

The following test panels shall be constructed and tested:

a) One test as part of laboratory mix testing carried out on each specific "watertight concrete" trial mixes during design.

b) One test for every 100m³ batch of "watertight concrete" for the first 4000m³.

c) Thereafter, one test for every 500m³ for the next 6000m³.

d) Thereafter, one test for every discreet element, namely floor slabs, sloped floor slabs, crest wall panels and columns, upon instruction by the Employer's Agent.

Any durability tests additional to the above as set out in subclause 7.3.6 a) to d) shall be requested at the discretion of the Employer's Agent and will be paid for as extras.

The durability tests are to be carried out by an accredited laboratory approved by the supplier in terms of his Quality Management System. Each test as quantified in the Bill of Quantities shall include each of the following tests:

- Oxygen permeability index test (OPI).
- Water sorptivity index test (including porosity).

e.g. 1 (One) No. of durability index test includes permeability testing and water sorptivity testing.

The test procedures for these tests are obtained from the University of Cape Town Durability Index Manual. One set of four (4 No. of) cores each (70mm diameter) are required from a test panel, with the same set of four cores that can be used for both the OPI test and the water sorptivity test. Once the cores have been extracted from the test panel, the test panel shall not be discarded and shall be kept on site to allow for possible further coring and testing if deemed necessary by the Employer's Agent. While the test panels are kept on site, they shall be kept in a manner that continues simulating the same exposure conditions as the structural element in question.

The required target values for the tests are summarised in the table below (these are the average values for the four core specimens used for the testing on each occasion). These values are required to be met simultaneously for each set of cores i.e., the same cores must pass the requirements for both the OPI and water sorptivity tests.

	Durability Index Test Results (x)	
Category	**OPI (log scale)**	**Water Sorptivity (mm/√h)**
(i) Laboratory (trial mixes)	$x \geq 10.0$	$X \leq 6$
(ii) Acceptance	$x \geq 9.7$	$x \leq 8.5$

The Contractor shall keep records of all test results relating to the samples tested and these records shall be made available to the Employer's Agent as and where requested.

The Contractor shall ensure that any site testing is carried out by a trained person. The Contractor shall ensure that all off-site laboratory testing is performed in an approved laboratory in terms of their Quality Management System.

7.3.2 Criteria for the Compliance with the Requirements (New Subclause 7.3.7)

No extra payment shall be made for cube strength testing. The cost of cube strength testing shall be deemed to be included in the rates tendered for concrete.

Water used for testing shall be free of charge except for failed tests when water will be charged at standard municipal rates.

In the event that the actual achieved average cube strengths of an element are less than 85% of the target mean strength, the Employer's Agent may instruct the taking of cores for additional strength testing. The cost of taking the cores and repairing the holes in the structures shall be for the Contractor's account.

Cover testing results obtained from the structure shall comply with the minimum concrete cover requirements as indicated on the reinforcement drawings. Durability Index test results (OPI and Sorptivity) obtained from testing of the test panels shall comply with the required target values as described in subclause 7.3.6.

If the above requirements are not met, reference is made to subclause 7.3.8.

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The Employer's Agent shall also reserve the right to conduct routine tests for the durability parameters on cores taken from the completed elements during the construction, the costs for which shall be to the Employer's account unless the parameters are not met. The acceptance criteria for such routine tests shall be as set out in subclauses 7.3.6.

Notwithstanding any of the above, the Employer's Agent shall reserve the right to deal with non-compliance as per subclause 7.3.8.

7.3.3 Procedure in the event of non-compliance (New Subclause 7.3.8)

Structural concrete elements or concrete pours shall be represented by test cubes and extracted cores/representative test panels, which shall be tested for strengths and the appropriate durability parameters.

If the required target values for durability parameters (concrete cover and durability index tests) are not achieved, the Contractor shall, subject to review of and approval by the Employer's Agent:

- Take remedial measures to ensure the identified assessed element achieves the required target values.
- Ensure that such remedial action is applied to any future pour /cast such that the required target values are also achieved on future element pours.

Remedial measures may include but not be limited to the following:

a) Changes/ optimisations in mix design

b) Changes / optimisation of site practices e.g. concrete placing, vibration / compaction, immediate protection and curing.

c) Coating/lining with an approved product where the design is specifically aimed at improving the non-conforming parameter, depending on the severity of the test results.

d) Demolition and rebuilding.

7.4 *ADD THE FOLLOWING NEW CLAUSE:* RESERVOIR STERILISATION PROCEDURE (NEW SUBCLAUSE 7.4)

Add the following new subclauses:

7.4.1 Sterilisation of Reservoir: Wash Down and Sterilisation (New subclause 7.4.1)

Prior to filling of the reservoir for watertightness testing (as per subclause 7.2.5), the reservoir shall be washed down and sterilised as follows:

All internal surfaces shall be thoroughly brushed to remove all rubble, dirt, contaminants and other foreign matter. The reservoir shall then be filled with water to a depth of 300mm and this water shall be uniformly chlorinated to a chlorine content of 20mg residual chlorine per litre of water. The chlorinated water shall then be sprayed by means of a pump and fire hose with fire nozzle over all internal surfaces including the floor slabs, columns, roof, piping, fittings and access points. All surfaces shall be brushed with the chlorinated water for sterilisation purposes.

Following the completion of wash down with the chlorinated water, the chlorinated water shall be carted away and disposed of at a suitable disposal facility site.

If any further work inside the reservoir should be called for after the reservoir has been sterilised, it shall be re-sterilised at the expense of the Contractor including the additional water to refill the reservoir.

During all stages of the disinfection/sterilisation of the reservoir structure and pipelines, the Contractor will be held responsible for the safeguarding the health of his employees.

7.4.2 Sterilisation of Reservoir: Sterilisation of full water volume (New subclause 7.4.2)

This clause will be applicable when watertightness testing, as per subclause 7.2.5, has been completed, but the testing for contaminants listed in subclause 7.2.5 has failed (i.e. one or more contaminants were present in the water samples). It is understood that the reservoir shall be at full supply level, considering watertightness testing has been completed, and that the water volume requires further sterilisation. The reservoir shall be sterilised as follows:

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Chlorine shall be added through the access openings in the roof slabs until the chlorine concentration in the reservoir is 20mg residual chlorine per litre of water. The reservoir shall then stand for a minimum of 48 hours where after water samples shall be taken and tested for microbiological contamination in accordance with subclause subclause 7.2.5. The sterilisation process shall be considered successful if none of the contaminants listed in subclause 7.2.5 are detected.

Procedures and methods for testing shall be as follows:

The water samples shall be taken at the four corners of the reservoir basin floor (flat portion of floor), four points within the basin floor footprint of the reservoir and at a point at the centre of the reservoir basin. The sampling water at each point shall occur at depths of 0.3m, 6.3m and 12m (9 sample points x 3 sample depths per point = 27 water samples in total – refer to subclause 7.2.5. for gridline references of sample points).

Testing of the water samples shall be undertaken by a SANAS accredited laboratory in terms of ISO/IEC 17025:2017.

After the completion of the watertightness testing and disinfection/sterilisation of the reservoir and inlet/outlet pipelines to the satisfaction of the Employer's Agent, the water may be released into the bulk water system, provided that it complies with the SANS 241 drinking water specification. To confirm this, a comprehensive water quality test according to SANS 241-1 and 241-2 shall also be done to ensure that the water is fully compliant. The Contractor shall be responsible for the costs of this compliance test. The water sample for the comprehensive SANS 241 compliance test can be three composite samples that are prepared by taking smaller water samples at 0.3m, 6.3m and 12m water depth on the four corners as well as in the centre of the reservoir. The individual samples taken at the various water depths shall be combined into a single sample to arrive at three separate water samples. The three (3) composite water samples shall be subjected to SANS 214-1 and SANS 241-2. Once the water in the reservoir is declared fully compliant, the water shall be released to the reticulation system in a controlled manner to ensure that the residual chlorine per litre water downstream does not exceed the requirements of the system. It is critical for the Contractor to note that the chlorinated water volume in the reservoir will need to stand for minimum 2 weeks to ensure that the concentration of the residual chlorine per litre of water is in accordance with acceptable supply standards. The Contractor is to make allowance for this standing period in his programme.

If any further work inside the reservoir should be called for after the reservoir has been sterilised, it shall be re-sterilised at the expense of the Contractor including the additional water to refill the reservoir.

During all stages of the disinfection/sterilisation of the reservoir structure and pipelines, the Contractor will be held responsible for the safeguarding the health of his employees.

7.4.3 Sterilisation of Reservoir: Re-sterilisation due to contamination (New subclause 7.4.3)

If upon completion of procedures set out in subclause 7.4.2 contaminants are detected in the water samples (following chlorination and testing as detailed in paragraph two of subclause 7.4.2), the chlorination process (addition of chlorine to the water until the chlorine concentration in the reservoir is 20mg residual chlorine per litre of water) shall be repeated. The reservoir shall again stand for 48 hours where after testing shall be conducted. Should any contaminants be detected for a third time, divers shall be deployed to inspect the reservoir for sources causing the contamination. Should a contamination source be located it shall be removed and disposed of appropriately, whereafter the chlorination process will be repeated.

The Contractor shall note that subclauses 7.4.1 and 7.4.2 cater for the removal of rubble, dirt, contaminants and other foreign matter and the sterilisation of the reservoir. If this is not completed successfully and in turn causes contamination which leads to repeating of the chlorination process to achieve successful sterilisation, this shall be at the expense of the Contractor and shall include all labour and materials required to remove the contaminants, the chlorine to re-sterilize the reservoir, additional water to refill the reservoir (if needed) and further necessary testing to confirm whether water is free of contaminants.

8. MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 MEASUREMENT AND RATES (SUBCLAUSE 8.1)

8.1.1 Formwork (Subclause 8.1.1)

Delete "and of fillets or splays over 20mm x 20mm" *from the first line of Subclause 8.1.1.2.*

Add the following to Subclause 8.1.1.2:

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"Splays, chamfers and fillets up to and including 40mm x 40mm will not be measured separately and will be deemed to be included in the formwork costs."

Add the following to the end of Subclause 8.1.1.3:

"f) For back shuttering or formwork to top of revealed sloping or conical surfaces which will only be measured to surfaces of 35° and up to 80° to the horizontal."

g) Notwithstanding 8.1.1.3 f), all formwork for the reservoir embankment (sloping) floors shall be measured separately from the formwork for the basin (horizontal) floors.

Add the following to the end of Subclause 8.1.1:

"8.1.1.7 For construction joints at kickers (in accordance with 5.5.7), all additional costs for formwork to edges up to 300mm (vertical kickers) will be deemed to be included in the rates tendered for vertical formwork to sides of walls and will not be measured separately in narrow widths.

8.1.1.8 Formwork to edges of blinding below the structure shall be measured separately from that required to form the designed sub-soil drainage compartments and for the localised blinding directly under column footings. No formwork will be measured to edges of blinding layers and no-fines concrete under structures on the outer perimeters and the cost thereof (if needed) will be deemed to be included in the rates tendered for concrete in blinding layers or no-fines concrete as applicable.

8.1.1.9 Formwork to horizontal surfaces in enclosed structures/chambers such as valve chambers, manholes or sumps shall either be removed through the manhole cover opening or the contractor may use permanent formwork at his own cost as no claims in this regard will be considered.

8.1.1.10 Larger splays, chamfers or fillets over 40mm will be measured by length in accordance with 8.2.5"

8.1.2 Reinforcement (Subclause 8.1.2)

Replace the contents of this Subclause with the following:

"The unit of measurement for steel bars shall be the ton of reinforcement in place, in accordance with the drawings or as authorised by the Employer's Agent.

The unit of measurement for welded steel fabric shall be the kilogram of fabric reinforcement in place, and the quantity, in kilograms, shall be calculated from the net area covered by the mesh, excluding overlaps.

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, welding, placing and fixing of the steel reinforcement, including all tying wire, stools, supports and waste."

8.1.3 Concrete (Subclause 8.1.3)

Delete ", or the plan size of the excavation where additional excavation is provided to facilitate erection of forms" from *Subclause 8.1.3.1(c).*

Add the words "(including requirements for trial mixes)" *after the words* "design of the mix" *in line 1 of Subclause 8.1.3.3.a).*

Delete the words "(made with ordinary Portland cement unless otherwise scheduled)*" in line 2 of Subclause 8.1.3.3.a).*

Add the words ", non-designated joints" *after the words* "stop-ends" *in line 3 of Subclause 8.1.3.3.a).*

Add the following to the end of Subclause 8.1.3.3:

" e) The rates for concrete shall also cover other concrete-related requirements specified but which are not scheduled separately."

8.2 SCHEDULED FORMWORK ITEMS (SUBCLAUSE 8.2)

8.2.1 Box Out Holes / Form Voids (subclause 8.2.6)

Add the following list items to 8.2.6

"(e) Larger, circular, of diameter over 0.7m up to and including 1.5m Unit : No.

Depths as in (a) above.

(f) Larger, other than circular, of area over 0.5m^2 up to and including 1.5 m^2 Unit : No.

Depths as in (a) above.

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(g) Larger, other than circular, of area over 1.5m² up to and including 2.5 m² Unit : No.

Depths as in (a) above.

Etc. for additional size categories as stated in the Bill of Quantities."

8.2.2 Roof Infill Shuttering (new subclause 8.2.7)

The unit for rates for infill shuttering as described in subclause 4.5.4 shall be per linear metre and shall include the cost for all labour and materials required for the approved method of shuttering proposed by the Contractor.

8.3 SCHEDULED REINFORCEMENT ITEMS (SUBCLAUSE 8.3)

8.3.1 High-Tensile Welded Mesh (Subclause 8.3.2)

Replace "Unit: m²" *with* "Unit: kg"

8.4 SCHEDULED CONCRETE ITEMS (SUBCLAUSE 8.4)

8.4.1 Strength concrete, grade (Subclause 8.4.3)

Replace the contents of this Subclause with the following:

"The grade and positions or elements in the Works will be stated. The type of cement and blended extender (if applicable) shall be as specified herein, or on drawings or Bill of Quantities

In the case of structural floor screeds, the unit of measurement shall be the square metre and the average thickness and proportions will be stated. Unless otherwise shown on the drawings, screeds will be deemed to have a wood-floated finish. The finish shall be inclusive in the rates and will not be measured separately."

8.4.2 Unformed surface finishes (Subclause 8.4.4)

Replace "Unit: m²" *with* "Unit: m² or m"

Replace Subclause 8.5 and its heading with the following:

8.5 JOINTS AND JOINT INTERSECTIONS (SUBCLAUSE 8.5)

8.5.1 Joints.....Unit: m or m²

Separate items will be scheduled for contraction and expansion joints of different types and sizes and involving different types, sizes , and qualities of water bars, soft board, sealers , etc.

The unit rate shall cover the cost of all materials and labour for the construction of each joint as specified or shown on the drawings, including the cost of formwork, testing, and making good.

Only designated joints as shown on the drawings will be measured for payment according to the length or square meter of each type of joint constructed (see 2.4.3). The rate shall cover the cost of all materials, labour and plant required to construct each type of joint scheduled, complete as specified on the drawings (including waterbars, sealants, dowels etc), and shall further include for the cost of all shuttering, preparation of concrete (as specified in 5.5.7), etc.

Non-designated joints (2.4.3) shall not be paid for separately and shall be assumed to be included in the various rates for concrete, reinforcing and formwork (this includes preparation of concrete to form said non-designated construction joints).

8.5.2 Joint intersections.....Unit: No.

Separate items will be scheduled for each type of joint intersection required. The unit rate shall cover the cost of all materials and labour for the installation of each joint intersection as specified or shown on the drawings, including the cost of special manufacturing, formwork, testing, and making good."

8.6 GROUTING (SUBCLAUSE 8.7)

Replace the last sentence of Subclause 8.7 with the following:

The rate shall further include all formwork necessary to complete the work.

Add the following to Subclause 8.7 (a):

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"Grouting in of equipment (such as base plates for machines) provided by the Contractor or by the Mechanical and Electrical Contractor will be measured by the volume of grout used.

The rate shall cover the cost of meeting the requirements of 5.5.19, and the supply and floating in of grout under the plates to ensure solid and complete filling of the gap."

Replace Subclause 8.7(b) and it's heading with the following:

"b) HD bolts ..... Unit: No.

Separate items will be scheduled for different diameters, lengths, and types. The quantity measured will be the number of bolts grouted in. No deduction will be made for bolts and packers protruding into the grout space."

Add the following to the end of Subclause 8.7:

"c) Grouting around pipes, etc..... Unit: m^3

If so scheduled, grouting around pipes and other mechanical equipment in boxouts or voids in concrete members will be measured by the volume of grout necessary to fill the voids and pockets between the outside surface of the pipe or mechanical equipment and the surface of the concrete wall/slab. The rate shall cover the cost of meeting the requirements of 5.5.16(c) and shall include all formwork necessary to complete the work. Grouting shall be watertight."

8.7 HD BOLTS AND MISCELLANEOUS METAL WORK (SUBCLAUSE 8.8)

Replace Subclause 8.8 and it's heading with the following:

"8.8 HD bolts (cast in and/or supply) ..... Unit: t or No.

a) Supply and casting in of HD bolts. The rate shall cover the cost of supplying, delivering and casting into concrete HD bolts as specified, and all cleaning, preparation, and finishing. The rate shall also cover the cost of meeting the requirements of 5.5.23, and all items and operations necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings.

b) Casting in of HD bolts. The rate shall cover the cost of taking delivery of HD bolts supplied by others, casting into concrete as specified, and all cleaning, preparation, and finishing. The rate shall also cover the cost of meeting the requirements of 5.5.23, and all items and operations necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings.

HD bolts that are already included in other rates (such as SANS 1200 H Subclause 8.3.1), will not also be measured here."

8.8 POLYETHYLENE SLIPSHEET UNDER CONCRETE SLABS (NEW SUBCLAUSE 8.9)

The impervious DPC membrane under concrete slabs shall consist of 375-micron (unless specified otherwise on the drawings or in the Bill of Quantities) polyethylene sheets, as indicated on the drawings. These sheets shall have minimum 200mm laps that are continuously taped and shall be measured by the surface area covered (laps and wastage are not measured). The rate shall cover the cost of the supply, laying, jointing of sheets as recommended by the supplier and final trimming of outer edges.

For the reservoir structure specifically, a 500-micron black continuous polyethylene sheet is to be laid over the no-fines concrete under the reservoir floor. The side and end laps shall not be less than 100 mm. Just before casting the sheeting shall be perforated at 1000mm centres along the joints and sheets shall have minimum 200mm laps that are continuously taped. Payment shall be measured by the surface area covered (laps and wastage not measured). The rate shall cover the cost of the supply, laying, jointing of sheets as recommended by the supplier and final trimming of outer edges Care shall be taken not to rip or tear the sheeting. All repairs shall be at the Contractor's expense. All repairs shall be at the Contractor's expense.

8.9 NO-FINES CONCRETE (NEW SUBCLAUSE 8.10)

No-fines concrete will be measured by area (unit of measurement shall be square meter) to the thickness as shown on the drawings or as scheduled. The provisions of Subclause 8.1.3 of SANS 1200 G shall apply *mutatis mutandis* and the rate shall include, if and where applicable / shown on the drawings, for geotextile bidim, and steel-floated 20mm mortar skim complete.

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8.10 SPECIALIST ADDITIVES TO CONCRETE (NEW SUBCLAUSE 8.11)

The unit of measurement shall be the cubic meter (extra-over) of concrete for the addition of a concrete crystallising waterproofing additive (Xypex C500NF or equivalent approved) or the addition of a microbial protective admixture (Xypex Bio-San C500, Penetron BioMIC or equivalent approved) to exact manufactures specifications.

8.11 GRANOLITHIC SCREEDING (NEW SUBCLAUSE 8.12)

Granolithic screeding will be measured as the square metre of screeds constructed (in plan view) to the average thickness as specified. The unit rate shall cover the cost of all materials, labour and equipment for the supply and application of the specified material, complete as specified in 5.5.25. Where a screed to fall is specified, the average thickness shall be stated. Repairs to unsatisfactory work will not be paid for. The rate shall also include the required float finish.

8.12 CASTING ITEMS IN CONCRETE (NEW SUBCLAUSE 8.13)

Casting items in concrete members (where so scheduled separately) will be measured by number for each type or range of items. The rate shall cover all costs related to fixing in position, formwork and casting in the item, including meeting the requirements of 5.5.16(b), 5.5.16(c) and 5.4. Where not scheduled separately, the rate for the applicable item shall include casting the item in concrete.

If the Contractor chooses (subject to the Employer's Agent's approval) to box out a hole and cast the item in subsequently, instead of casting the item into the concrete member simultaneously to casting of the concrete member, this rate shall also cover these activities and the requirements of 5.5.16(a).

8.13 CREATING BOXOUTS IN CONCRETE FOR OTHERS TO CAST ITEMS IN (NEW SUBCLAUSE 8.14)

Box-outs created in accordance with 5.5.16(a) for items to be cast in concrete by others will be measured by number separately for each type of item or range of items.

The rate shall cover the cost of creating the box-out, maintaining continuous reinforcing, removing all formwork and boxing remaining in the holes, and thoroughly scabbling the sides of the holes so as to obtain a satisfactory bond surface for the new concrete, as described in 5.5.16(a). As this rate already includes for creating box-outs, no additional payment will be made under 8.2.6.

8.14 PRECAST PAVING SLABS (NEW SUBCLAUSE 8.15)

Precast paving slabs will be measured by the area paved.

The rate shall cover the cost of compacting the area, application of weed-killer, supplying, laying and bedding the slabs, grouting the joints and filling any gaps, all as specified.

8.15 MISCELLANEOUS/MINOR REINFORCED CONCRETE/BRICK STRUCTURES (NEW SUBCLAUSE 8.16)

Where minor reinforced concrete and brick structures have been scheduled in the Bill of Quantities, the sum tendered for each item shall cover the cost of all material (including handrailing, banded grating, flooring, ladders where applicable, weir plates and handstops), plant and labour involved in constructing the said item (including 0,12t of high tensile steel per m^3 of concrete where the amount of reinforcement is not indicated on the drawings) according to the drawings and relevant specifications. Unless otherwise stated in the Bill of Quantities, the sum tendered shall also cover the cost of all excavation and backfilling, and if applicable, watertightness testing.

8.16 BREAKING INTO AND BUILDING ON TO EXISTING STRUCTURES (NEW SUBCLAUSE 8.17)

Where it is necessary for the Contractor to break into and/or build into or onto an existing structure, such an activity shall be measured and paid by the sum.

The sums tendered shall cover the cost of dealing with the water (and/or any other contents) in the existing structure (where applicable), breaking away existing concrete, penetration of exposed concrete surfaces, supply and application of a wet to dry epoxy, liaison with the Employer's Agent and the Employer to facilitate the work as specified and all materials or activities not measured elsewhere to complete the construction as specified including joining materials, supply and epoxying in of dowel bars etc.

Where it is required to break into existing structures in order to build in new pipes, the rate tendered shall cover the cost of ensuring that a watertight seal is achieved.

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8.17 EMPTYING OF EXISTING STRUCTURES (NEW SUBCLAUSE 8.18)

The unit of measurement shall be the cubic meter of water/sludge/sand/grit removed, as well as any applicable transport and disposal costs. The following broad categories will be specified:

(a) Pumping of water/sludge to adjacent or nearby structure/location as instructed as specified.

(b) Manual removal of sludge/sand/grit to specified location.

For (b) above, "manual" implies removal by hand unless otherwise specified. If the location is specified off-site in the Bill of Quantities or by the Employer's Agent, then the rate supplied by the Contractor will include haulage and any disposal permit costs. Hazardous waste needs to be disposed of appropriately at an appropriate disposal facility.

8.18 CLEANING OF EXISTING STRUCTURES (NEW SUBCLAUSE 8.19)

The unit of measurement shall be the square meter of surface to be cleaned. The minimum pressure rating of the waterjet (if applicable) will be stated in the Bill of Quantities. The surface must be accepted by the Employer's Agent as cleaned of any dirt, grease, stains and other contaminants to an acceptable standard.

8.19 DOWELS (NEW SUBCLAUSE 8.20)

Separate items will be scheduled for each reinforcing diameter.

The unit of measurement shall be the number of dowels installed with a suitable epoxy anchor grout designed for reinforcing bars (Fischer FIS EM Injection Mortar, Sika Anchorfix II, Hilti HIT-RE 500, or similar approved) to exact manufacturer's specifications to a minimum embedment depth as indicated below:

Size	Minimum Embedment Depth (mm)
R/Y10	150
R/Y12	150
R/Y16	200
Y20	300
Y25	400

Where dowels are required, the holes are to be drilled with a masonry/percussion drill-bit not capable of cutting through reinforcing.

The tendered rate shall include full compensation for drilling to the required depths (including any costs associated with avoiding reinforcing in the base member and filling of unused holes with an approved mortar), supplying the epoxy anchor grout and installation of the dowels in the epoxy anchor-grout. The reinforcing bars shall be measured as per 8.1.2.

8.20 WATERTIGHTNESS TESTING (NEW SUBCLAUSE 8.21)

Watertightness tests shall be paid by a lump sum separately for each structure, or by a number for the components of the structures successfully passing the test as scheduled.

Where water for testing will be sourced from the incoming pipeline flow, the sum or number shall cover the cost of all, labour, equipment and materials to carry out the tests, as specified in subclause 7.2.5, including all that is required for the installation of temporary watertight closures and associated props/anchors for openings. Where water for testing will not be sourced from the incoming pipeline flow, The sum or number shall also cover the cost of providing all water necessary for testing.

The sum or number shall also include the rectifying of faults and re-testing to achieve a test result to the satisfaction of the Employer's Agent. No extra payment will be made for re-testing during the Defects Liability Period if leaks in the structure have been observed, thus leading to the Employer's Agent's instruction to undertake the re-testing.

8.21 STERILIZATION OF WATER RETAINING STRUCTURES (NEW SUBCLAUSE 8.22)

The tendered sum shall include full compensation for sterilizing the structure as specified.

8.22 CONCRETE PROTECTION AND PROPRIETARY FLOOR FINISHES (NEW SUBCLAUSE 8.23)

The unit of measurement shall be the square metre of finish (see 5.5.26 for finishes) required, but with skirting measured per meter. Separate items will be scheduled for each type of finish / concrete protection required.

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The tendered rates shall include full compensation for all labour, plant, equipment, material, transport, etc., substrate preparation and providing and installing all products necessary to complete the concrete protection/finish, inclusive of trim (e.g. aluminium edging), grooves, joints and sealing of interfaces.

Steel or timber skirting (excluding trim which is included in the rate for the finish) shall be measured and paid for elsewhere (steel skirting under SANS 1200 H and timber skirting under Specification PD).

8.23 PREPARATION OF BASE CONCRETE TO RECEIVE BENCHING (NEW SUBCLAUSE 8.24)

The unit of measurement shall be the square metre of base concrete to be prepared for receiving benching. The rate shall cover chipping/scabbling the base concrete to remove all laitance and expose the aggregate over 100% of the area to be benched using mechanized plant such as scabblers or abrasive blasters. The rate shall further include cleaning the surface from all dust and debris by scrubbing and/or high-pressure wash, followed by soaking the surface with water for at least 24 hours.

8.24 APPLICATION OF AN EXPANSION/MOVEMENT JOINT BRIDGING FLEXIBLE WATERSTOP (NEW SUBCLAUSE 8.25)

Joint bridging flexible waterstops specified on the joint detail drawings (for example 'Joint W') are deemed to be included in the rate for joints (see 8.5) and shall not be measured here also.

The unit of measurement shall be the meter running length of proprietary product applied. The tendered rates shall include full compensation for:

Application of 200mm wide, 2mm thick Sikadur-CombiFlex SG system (or equivalent approved), including all preparation and epoxy adhesive, joints, etc., by a supplier-approved applicator between concrete edges to provide a water-tight seal to the exact manufacturer's specifications.

8.25 SWELLABLE WATERSTOP (NEW SUBCLAUSE 8.26)

Swellable waterstops specified on the joint detail drawings (for example 'Joint V') are deemed to be included in the rate for joints (see 8.5) and shall not be measured here also.

The unit of measurement shall be the meter running length of proprietary product applied. The tendered rate shall include full compensation for:

Application of SikaSwell S-2 + SikaSwell A 2010, or Xypex Kuniseal C31-DS (or other similar approved products) by a supplier-approved applicator, including substrate preparation to provide a watertight seal to the exact manufacturer's specifications.

8.26 SHEAR LOAD CONNECTORS (NEW SUBCLAUSE 8.27)

Where shear load connectors have been scheduled in the Bill of Quantities, they will be measured in the unit scheduled.

The sum or rate for such item shall cover the cost of all materials, labour and plant required to execute and complete the work as specified, described in the Bill of Quantities or shown on the drawing(s).

8.27 STERILISATION OF RESERVOIR: WASH DOWN AND STERILISATION (NEW SUBCLAUSE 8.28)

The tendered sum shall include all labour, plant, materials and resources (including the supply of water) to wash down and sterilise the reservoir as per subclause 7.4.1.

8.28 STERILISATION OF RESERVOIR: STERILISATION OF FULL WATER VOLUME (NEW SUBCLAUSE 8.29)

The tendered sum shall include all labour, plant, materials, resources and testing (including the supply of water) to sterilise the reservoir as per subclause 7.4.2.

8.29 JOINT PROTECTORS (NEW SUBCLAUSE 8.30)

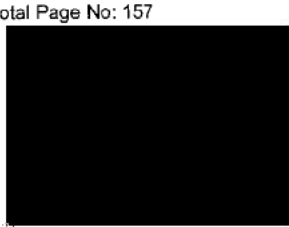
The unit of measurement shall be the meter running length of joint protector applied.

Joint protectors will be provided as per details on the drawings. The tendered rates supplied for joint protectors shall include all fabrication, labour such as welding, material and installation costs.

8.30 DURABILITY TESTS (NEW SUBCLAUSE 8.31)

8.31.1 Durability Index Tests ..... Unit: No (as per clause 7.2.7 a) and b) and 7.3.6).

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The rate shall cover the cost of all labour, plant and materials to carry out the tests specified in subclause 7.2.7. Durability tests will include tests for Sorptivity, Oxygen Permeability as specified in subclause 7.2.7 and 7.3.6. All costs of any remedial action that is deemed necessary to achieve the minimum durability target values specified in subclause 7.3.6 shall be borne by the Contractor.

8.31.2 Concrete Cover Tests..... Unit: Sum (as per clause 7.2.7 c).

The sum shall cover the cost of all labour, plant and materials to carry out the tests specified in subclause 7.2.7. All costs of any remedial action that is deemed necessary to achieve the minimum cover values specified on the drawings shall be borne by the Contractor.

8.31 MISCELLANEOUS WORK (NEW SUBCLAUSE 8.32)

Separate items will be scheduled for each type of miscellaneous work as described in the Bill of Quantities and shown on the drawings (with drawing number stated). The unit of measurement shall be as scheduled in the Bill of Quantities. The tendered rates shall include full compensation for providing all labour, plant, materials, equipment and transportation etc. required to carry out the work, for all proprietary work, for preparation and construction of the work scheduled in a workmanlike manner and for finishing-off and cleaning up when the work has been completed.

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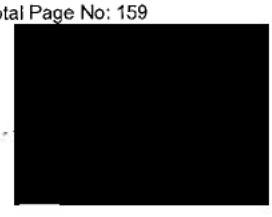


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1. SCOPE (CLAUSE 1)

No amendments.

2. INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (SUBCLAUSE 2.3)

Add the following definitions:

"Anchorage reinforcement :

Anchorage reinforcement is the spiral and other reinforcement, as per the Contractor's design, that forms part of the anchorage and is required to strengthen the anchorage and/or assist in transmitting the tendon force into the concrete.

Bursting reinforcement :

Bursting reinforcement is the reinforcing steel, as per the Contractor's design, required in and adjacent to the anchorage zones to resist the tensile stresses induced in the concrete by the anchorage(s)."

3. MATERIALS (CLAUSE 3)

3.1 GENERAL (SUBCLAUSE 3.2)

3.1.1 Hollow Core Slabs (New Subclause 3.1.1)

"Precast Prestressed Hollow Core Slabs shall have a minimum characteristic strength of 50 MPa. A typical hollow core slab design is indicated on the drawings.

Different types of hollow core slabs are shown on the drawings, each with specific pre-stressing strand arrangements and widths/dimensions for different applicable spans.

The hollow core slab design shall be the responsibility of the Contractor, but is subject to approval by the Employer's Agent. Slabs shall be designed for the loadings and in accordance with the design requirements as indicated on the drawings. The slab design shall take into account the roof penetrations as shown.

A detailed design shall be submitted to the Employer's Agent for approval at least 56 days before commencing manufacture of any slabs. The hollow core slabs shall be manufactured by a reputable manufacturer with a proven track record in the mass production of such slabs in large volumes. The supplier shall have an approved quality management system which will be subject to audit before commencement of manufacture.

The Employer's Agent reserves the right to reject any supplier that in his/her opinion does not possess the relevant credentials for the supply of these elements."

3.1.2 Precast beams (New Subclause 3.1.2)

"Beams used in conjunction with the precast hollow-core slabs shall be precast and pretensioned as indicated on the drawings. All beams shall have a minimum characteristic strength of 35 MPa prior to the release of prestressing and a minimum characteristic strength of 45 MPa after all long-term losses have been accounted for.

The beam design shall be the responsibility of the Contractor, but is subject to approval by the Employer's Agent. Beams shall be designed for the loadings and in accordance with the design requirements as indicated on the drawings.

A detailed design shall be submitted to the Employer's Agent for approval at least 56 days before commencing manufacture of any beams. The beams shall be manufactured by a reputable manufacturer with a proven track record in the mass production of such elements in large volumes. The supplier shall have an approved quality management system which will be subject to audit before commencement of manufacture.

Prestressing of the pretensioned beams shall comply with SANS 1200 GF along with the amendments to SANS 1200 GF. The stressing of prestressed units shall be completed before they are erected but not before the concrete has reached the specified strength.

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The Employer's Agent reserves the right to reject any supplier that in his/her opinion does not possess the relevant credentials for the supply of these elements."

3.2 TENDONS (SUBCLAUSE 3.3)

Replace the contents of this Subclause with the following:

"Tendons shall consist of high tensile strands as indicated on the drawings. Strands shall be low relaxation strands and shall comply with the requirements of BS 5896 for hot-rolled and processed bars. These strands shall have a minimum UTS of 1860 MPa.

The strands for the precast beams shall have a nominal diameter and Elastic Modulus as indicated on the drawings. Strands for the hollow core prestressed slabs shall have nominal diameters and Elastic Modulus as indicated on the drawings.

The Contractor shall obtain from the manufacturer in respect of each consignment of steel for tendons a certificate stating the quality and the mechanical properties and shall provide the Employer's Agent with a copy."

3.3 ANCHORAGES AND COUPLERS (SUBCLAUSE 3.4)

Add the following:

Anchors shall be as indicated on the drawings.

3.4 SHEATHS (SUBCLAUSE 3.5)

Add the following:

In the case of post-tensioned beams, prestressing ducts for post-tensioned precast beams shall be corrugated metal sheathing. Sheaths shall have an internal diameter of 60mm and external diameter of 65 mm.

Metal sheathing shall be delivered to site protected against damage and corrosion. At the time of incorporation into the support beam the sheathing shall be free from loose millscale, loose rust, lubricants and harmful matter.

Galvanised sheathing shall not be used unless specified.

Connections to and joints in sheaths shall be made grout-tight by using special sheathing couplings and taping. The length of taping shall extend at least three sheath diameters on either side of the joint. Where oversleeves are used, overlaps equal to 3 sheath diameters shall be provided over each length of sheathing. Joints in adjacent sheaths shall be spaced at least 300mm apart.

3.5 BEARING PADS (NEW SUBCLAUSE 3.7)

Bearing pads supplied will be Laminated Elastomeric Bearings in 60° natural rubber and should be designed according to BS5400.

Bearings of size and thickness as indicated on the drawings will be required for the support of the beams on the column heads and perimeter crest wall.

The Contractor will submit to the Employer's Agent for approval drawings of the elastomeric bearings proposed which indicate the following:

a) Design loads and deformations i.e. the critical design-load combinations and co-existing rotations and horizontal displacements for each bearing or each group of identical bearings.

b) The IRHD hardness of the bearings.

c) Identification i.e. each bearing shall be identified by a number.

3.5.1 Storage of Bearings (New Subclause 3.7.1)

The bearings shall always be stored under cover and clear of the ground, away from sunlight, heat, oils and chemicals deleterious to the bearings. The bearings shall not be stacked in a manner or on a surface which will cause distortion of the bearings.

The bearings shall be handled with care to ensure that they are not subjected to impact loads or any other conditions which may be harmful.

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3.5.2 Installation of Bearings (New Subclause 3.7.2)

The concrete surfaces of elements required to receive bearings shall be steel-floated. Plastering of the surface will not be permitted under any circumstances.

Where epoxy mortar bedding is required, the concrete surface shall be roughened. Bonding of the epoxy mortar bedding to the concrete surface shall be in accordance with the manufacturer's recommendations.

The bearings shall be accurately installed to the specified level, alignment and orientation to the following tolerances:

- Plan position shown on drawings: ±3mm
- Required level ±1mm

Before the bearing is incorporated into the structure, it shall be cleaned to remove all deleterious substances and adhering matter.

3.6 EPOXY MORTAR BEDDING (NEW SUBCLAUSE 3.8)

Mortar beddings for seating bearings shall be composed of an approved sand and epoxy resin mortar. The cured compressive cube strength of the mortar shall be not less than 2x the average contact stress under the bearing or 35 MPa, whichever is the greater.

4. PLANT (CLAUSE 4)

4.1 HANDLING, LIFTING AND STACKING EQUIPMENT (SUBCLAUSE 4.8)

Add the following:

"The Contractor shall submit details of handling, storage and placing operations as a method statement to the Employer's Agent for approval at least 7 days prior to construction."

5. CONSTRUCTION (CLAUSE 5)

5.1 GENERAL (SUBCLAUSE 5.1)

Add the following:

The support beams shall preferably be cast in a yard established on site. Approval may be given to off-site manufacture in a yard established by the Contractor or at an independent existing factory run by an approved suitably experienced sub-contractor. Details of the proposed yard/factory and the manufacturer shall be given in the tender and the Employer's Agent's written approval of these details shall be obtained before manufacture is commenced. Details of the standard and special plant, equipment and methods proposed for handling, transport and placing the members shall be given in the tender and shall be approved by the Employer's Agent in writing before manufacture is commenced.

Before the casting yard is established, the Contractor shall submit plans to the Employer's Agent which demarcate the site and detail the layout of the works together with a flow diagram of the construction stages and storage.

If the casting yard is located off-site, the Contractor shall notify the Employer's Agent in advance of the dates for casting of members and when tensioning of tendons will be undertaken.

Where the Employer's Agent requires the tests to be conducted on completed units, no unit to which the tests relate shall be dispatched to the site until the tests have been satisfactorily completed and the members accepted by the Employer's Agent.

At least 6 weeks prior to work being commenced on the setting up of the pre-casting yards and production of the first units, details of the manufacture and phasing the works shall be submitted to the Employer's Agent for approval. After approval no change shall be made to the method or systems without approval by the Employer's Agent.

Pre-cast units which have not been fully tensioned or fully stage tensioned or which have ungrouted tensioned tendons shall not be handled without authorization of the Employer's Agent.

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Where units with ungrouted tensioned tendons are handled, control shall be exercised to guard against possible slip of the tendon at the anchorage."

5.1.1 Records of Drawings and Calculations (New Subclause 5.1.1)

"The Contractor shall submit to the Employer's Agent at least 2 months before he intends to commence with the prestressing work, calculations in respect of the design of the hollow core slabs and beams as defined in subclause 3.1.1 and 3.1.2 respectively.

The Employer's Agent, at his own discretion, may call for further information in the form of detailed drawings, proof of successful previous use, performance certificates from an approved independent testing authority and calculations substantiating the adequacy of the system. The Contractor shall furnish such information within 2 weeks of being called upon to do so or within a period agreed to by the Employer's Agent. If, after investigating all the information, the Employer's Agent is not satisfied that the design of the hollow core system and precast beams offered by the Contractor can fulfil its function, the Employer's Agent reserves the right to order the Contractor to use any system which is suited to the work and which is readily available to the Contractor.

After approval by the Employer's Agent of the drawings and calculations prepared by the Contractor, no departure shall be permitted from the design without authorization by the Employer's Agent.

Manufacture of hollow core slabs and beams shall not commence before the relevant information, drawings and design have been approved by the Employer's Agent. The Contractor shall make full allowance in his tendered rates for all costs in connection with the furnishing of information, producing calculations and preparing and submitting the drawings.

5.2 TENDONS (SUBCLAUSE 5.4)

Add the following to subclause 5.4:

"Prestressing shall be so designed as to attain the prestress force at transfer within the limits specified. The calculations shall indicate the forces that the Contractor proposes to apply and the corresponding extensions.

Any extra reinforcement required by the Contractor to supports or hold in position the tendons shall be included in the rate for prestressing."

5.2.1 Cutting (Subclause 5.4.3)

Add the following:

"All cutting of prestressing steel shall be performed with a high-speed abrasive cutting wheel or by a method approved by the Employer's Agent. Flame cutting will not be permitted under any circumstances.

Care shall be taken to prevent the prestressing steel or anchorages from coming into contact with splashes from flame cutting or welding processes in the vicinity."

5.2.2 Positioning of Tendons and Sheaths (Subclause 5.4.4)

Add the following to Subclause 5.4.4.1:

"The cable sheath shall be accurately installed to the specified alignment, securely held in position both vertically and horizontally at intervals appropriate to its rigidity and so as not to be displaced during concreting either by the weight of the concrete or by buoyancy. The spacing of the cable carriers shall ensure that the tendon can be installed to a smooth alignment without kinks and within the tolerance as specified. The spacing between the cable carriers shall be between 1.0m and 1.5m."

Add the following to Subclause 5.4.4.2:

"Unless otherwise shown on the drawings, the alignment of the tendon within a distance of 1m from the live anchorage shall be straight. The tendon axis shall be set perpendicular to the bearing surface of its anchorage and firmly secured in position so as not to move during concreting."

Add the following to Subclause 5.4.4.3:

"The spacing of tendons and/or sheaths shall depend on the size of the tendon or sheath and shall be such that the concrete can be properly placed and compacted around the sheaths.

Add the following to Subclause 5.4.4.5:

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"Connections to and joints in sheaths shall be made grout-tight by using special sheathing couplings and taping. The length of taping shall extend at least three sheath diameters on either side of the joint. Where oversleeves are used, overlaps equal to three sheath diameters shall be provided over each length of sheathing."

5.2.3 Tensioning Procedure (Subclause 5.4.5)

5.2.3.1 General (Subclause 5.4.5.1)

Add the following:

"A high degree of consistency and control during the manufacture and stressing of the prestressed units is required so that all elements have a uniform flexural behaviour. As far as possible, all units should be exposed to similar environmental conditions during curing. All elements shall be stressed at the same cube strength and age with a variation in age of ±1 day being allowed for stressing at 7 days age or ±2 days for stressing at 14 days age. Should the Contractor elect an intermediate time of stressing, the variation and stressing time shall be interpolated between the above values.

The variation for earlier stressing shall be agreed with the Employer's Agent. The Contractor shall not vary the concrete mix proportions nor the time of stressing during the production of the units.

Loss of prestressing force:

Any structural member which has lost all or part of its prestress through the failure or malfunction of any part of the prestressing component shall be rejected by the Employer's Agent and shall be removed from the works unless approved remedial measures have been successfully carried out on the member. No payment will be made in respect of such remedial work or loss suffered by the Contractor in this regard."

5.3 GROUTING OF SHEATHS (SUBCLAUSE 5.5)

5.3.1 Sheaths (Subclause 5.5.2)

Add the following:

"Sheaths shall be fitted at both ends with pipes with a diameter of at least 10mm for the injection of grout. The ends of the injection pipe shall be fitted with a clamp valve or device capable of withstanding a pressure of at least 15 bars without loss of grout."

5.3.2 Grout (Subclause 5.5.3)

Add the following:

"The use of admixtures in the grout shall be subject to tests having shown that the use improves the properties of the grout e.g. by increasing workability, reducing bleeding, entraining air or expanding the grout. Admixtures shall be free from any product liable to damage the steel or the grout itself, such as halides, nitrates, sulphides, sulphates, etc.. The quantity of admixture to be used shall be in accordance with the manufacturer's instructions.

- The neat grout shall have the following properties:
- The Cl ions content shall not exceed 750mg per litre.
- The viscosity of the grout for horizontal cables shall be 500-2500cP. The viscosity of the grout 20 minutes after mixing shall not exceed 2500cP.

Bleeding at 20°C shall not exceed 2% by volume 3 hours after the grout has been mixed and the maximum bleeding shall not exceed 4%. In addition the separated bleed water must be reabsorbed after 24 hours."

5.4 HANDLING AND ERECTION OF PRESTRESSED UNITS (SUBCLAUSE 5.7)

5.4.1 Handling, Transportation and Storage (Subclause 5.7.1)

Add the following:

"The Contractor is responsible for the design of the prestressed units for lifting and erection and for temporary shoring and bracing until such time as the units are permanently connected to and supported by the columns. To this end, the Contractor shall employ a professionally registered Employer's Agent to execute such designs.

"The pre-cast units shall be lifted by approved means at approved points. When elements are stacked, they shall be supported at their final support positions. The Contractor shall submit details of his proposed lifting,

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moving and stacking equipment, the temporary bearing positions and lifting points together with calculations of flexural stresses to the Employer's Agent for approval."

5.4.2 Launching of Beams and Slabs (New Subclause 5.7.4)

"Extreme care shall be exercised during the launching operations to prevent and buckling or twisting of the beams. The Contractor, if he so elects, will be allowed to launch the precast hollow core units over the support beams which have already been placed in position provided that the support beams which are to be traversed are adequately secured and that the gantries and girders, etc. used to transport the units do not overstress the units nor impose any lateral loads or excessive longitudinal loads on them.

At least 8 weeks prior to commencing the launching operations, the Contractor shall provide for the Employer's Agent's approval, details of the launching gantries, girders and any other equipment together with the maximum loads which will be imposed on the members to be traversed. Calculations shall be submitted indicating the stresses in the pre-cast prestressed units under these launching loads."

6. TOLERANCES (CLAUSE 6)

6.1 PRESTRESSING (SUBCLAUSE 6.2)

Add the following:

Degree of Accuracy I shall apply to all precast prestressed units.

7. TESTS (CLAUSE 7)

7.1 LOAD TESTS ON INDIVIDUAL PRESTRESSED UNITS (SUBCLAUSE 7.2)

7.1.1 General (subclause 7.2.1)

Add the following:

The Contractor shall carry out non-destructive tests on samples of the roof panels selected by the Employer's Agent on the basis of the following sample frequency or as may be directed by the Employer's Agent.

Roof Panels: 1 Sample per 500 roof panels

At least 6 weeks prior to the commencement of manufacture of the roof panel units, the Contractor shall provide details of the testing rig/s which is intended to be used for load testing the precast prestressed units, the manner in which the load will be applied and the type of measuring devices which will be provided in order to measure the load and deflection of the units.

The details of the loading to be applied shall be agreed with the Employer's Agent to represent the maximum service loading to be expected on the panel. The panel shall be considered to have passed the test, provided that there is no visible cracking and that the deflections are within allowable limits.

7.1.2 Non-destructive (Service) Test (subclause 7.2.2)

Add the following:

"The precast prestressed units shall be test loaded for loads to be agreed upon by the Employer's Agent. The load shall be applied in 5 equal increments with each load being maintained for a period of 5 minutes. Deflection measurements at the supports and mid-span shall be recorded for each load increment. The maximum load shall be maintained for a period of 15 minutes, The load shall be removed in 5 equal decrements and the deflections measured at each stage. The recovery shall be measured 30 minutes after the removal of the applied load.

The load shall then be reimposed in 5 equal stages. The percentage recovery after the second loading shall be at least equal to that determined after the first loading and at least 90% of the deflection recorded during the second loading."

7.2 TESTS ON BEARINGS (NEW SUBCLAUSE 7.5)

The Contractor shall submit test certificates from an approved, independent testing authority to show that the respective materials used for the bearings comply with the specified requirements.

On completion of the manufacture of the bearings, the Contractor shall submit bearings selected by the Employer's Agent, to an independent testing authority for testing.

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The testing facilities of the manufacturer or supplier may be used if so approved and on condition that the tests are conducted in the presence of the Employer's Agent.

Copies of test results and certificates for the abovementioned tests shall be submitted by the Contractor to the Employer's Agent in good time to enable the Employer's Agent to assess the information before the bearings are installed.

The Employer's Agent is to determine which tests are to be conducted. The tests and testing shall comply with the appropriate requirements of BS 5400 part 9.2 and all costs associated with the testing shall be deemed to be included in the tendered rates for the bearings.

Ten percent of each type of bearing fabricated shall be load tested by being subjected simultaneously to a vertical load equal to 150% of the maximum design load, and to shear distortion equal to 150% of the maximum design value.

8. MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Manufacture of Precast Prestressed Units (Subclause 8.2.2)

Replace the contents of this subclause with the following:

8.1.1.1 Manufacture and installation of Precast Prestressed Beams (New Subclause 8.2.2.1)

The unit of measurement shall be the number of beams that will be supplied as indicated on the drawings.

The rate provided for these beams shall include the cost of royalties, material including concrete and prestressing steel, formwork and moulds and of all labour and equipment required for mixing, placing, compacting, floating off, stressing, temporary stacking and curing. The rate shall also include the cost of materials and labour required for all couplers, anchorages, bursting reinforcing and other reinforcing, jacking, bolting, tendons and/or grouting of the tendons as detailed on the drawings, as well as any testing required by the Employer's Agent as per subclause 7.2.

8.1.1.2 Manufacture and installation of Precast Hollow Core Roof Slabs (New Subclause 8.2.2.2)

The unit of measurement shall be the square metre area of hollow core roof slabs that will be supplied as indicated on the drawings.

The rate provided for these slabs shall include the cost of royalties, material including concrete, and prestressing steel, formwork and moulds and of all labour and equipment required for mixing, placing, compacting, floating off, stressing, temporary stacking and curing. The rate provided shall make provision for different slab types as indicated on the drawings as well as different prestressing arrangements and shall also include cut panels at the positions of roof light openings and manhole/ plug covers openings.

The rates shall include the cost for materials and labour required for couplers, anchorages, reinforcing, bolting, jacking, tendons and grouting of the tendons as detailed on the drawings, as well as any testing required by the Employer's Agent as per subclause 7.2."

8.1.2 Alternatives to subclauses 8.2.3.2 and 8.2.3.3 (Subclause 8.2.7)

8.1.2.1 Laminated Elastomeric Bearing Pads (New Subclause 8.2.7.3)

The unit of measurement shall be the number of bearing pads that will be supplied as indicated on the drawings.

Laminated Elastomeric Bearing Pads are to be placed as a seating underneath beams. Bearing pads of size and details as specified on the drawings will be required for supporting the beams on the tops of the columns and on the reservoir perimeter crest wall.

Payment will be per number and the tendered rate shall include the cost for supply and installation of each bearing including any epoxy bedding material, as well as any testing requested by the Employer's Agent as per subclause 3.7 and 7.5.

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS AND ABBREVIATION (SUBCLAUSE 2.3)

Add the following abbreviations to the end of this Subclause:

"HDG. Hot dip galvanized or hot dip galvanizing (steel), as applicable

SS. Stainless Steel

"Covered open grid flooring" and "covered grating" shall be taken to mean open grid flooring with a permanently attached solid top steel cover of the same material and finish as the grid flooring. Figure 2.3a illustrates covered open grid flooring (unbanded).

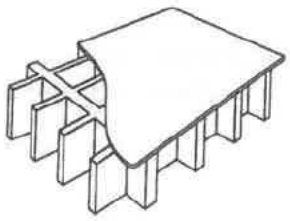


Figure 2.3a: An example of covered open grid flooring (unbanded), cover partially removed for illustration."

3 MATERIALS (CLAUSE 3)

3.1 STRUCTURAL STEEL (SUBCLAUSE 3.1)

Add the following after the first sentence of Subclause 3.1.1:

"Steel shall be Grade S355JR for hot rolled steel sections. All members shall carry the Grade S355JR steel symbol to identify steel grade prior to manufacturing. Mill test certificates to be provided to the Engineer for all structural steel, prior to manufacture. Where stainless steel is specified, the grade of stainless steel shall be Grade 316L unless otherwise stated."

3.2 BOLTS, NUTS AND WASHERS (SUBCLAUSE 3.6)

3.2.1 Bolts and nuts (other than friction-grip) (Subclause 3.6.1)

Add the following:

"All bolts, nuts and washers (i.e. fasteners) in the following categories shall be manufactured from Grade 316L stainless steel and shall have a nickel-based anti-seize compound applied along the full length of fastener threads before the nut is applied:

- Those with a diameter of 10mm or less.
- Those of any size used in conjunction with stainless steel items.
- All anchor fasteners of any size in concrete or brickwork, unless otherwise specified.
- All those within water-retaining structures, water-excluding structures or exposed to the rain

All other bolts, nuts and washers, not listed in the categories above, shall be hot-dip galvanized (HDG) to SANS 121 and painted as per Sans 1200 HC Subclause 5.12. HDG nuts shall be tapped before galvanizing, taking into consideration the extra clearance necessary to allow for the thickness of galvanizing on the bolts. If, after installation, there is any indication that galvanising has been stripped from either the nut or the bolt, both nut and bolt shall be removed and replaced. In the case of protective paint being stripped after installation from either the nut or the bolt, refer to item d) in SANS 1200 HC Subclause 5.12.

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All bolts for structural steel shall be Class 8.8 bolts."

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 DRAWINGS AND SHOP DETAILS (SUBCLAUSE 5.1)

5.1.1 Design drawings (Subclause 5.1.1)

Add the following:

"The Contractor shall be solely responsible for the final verification of all steelwork dimensions (including confirmation of all relevant dimensions on site) before preparing his shop drawings and manufacturing any steelwork components."

5.1.2 Contractor provides shop details (Subclause 5.1.2)

Add the following:

"The Contractor shall be responsible for the preparation, in accordance with SANS 10162:2011, of shop drawings and/or details, drawn using Tekla or similar approved software. The drawings (including all applicable .IFC and .TBP files) shall be submitted for approval at least two weeks prior to commencement of fabrication. The Engineer will check the drawings for conformity with design requirements and will return the drawings with additions and corrections, if any, within ten working days of having received them. Detailed checking of shop details for dimensional accuracy and installation fit, will not be done by the Engineer."

5.2 FABRICATION (SUBCLAUSE 5.2)

5.2.1 General (Subclause 5.2.1)

Add the following to the beginning of this Subclause:

"Before commencing with any manufacturing or construction of structural steelwork, the Contractor shall confirm all relevant dimensions on site. Any discrepancies should be brought to the attention of the Engineer immediately."

Add the following to the end of this Subclause:

"The main structural members shall be single full length."

5.2.2 Cutting (Subclause 5.2.3)

Add the following to the end of this Subclause:

"The edges of flame-cut plates shall be ground off and smoothed."

5.2.3 Holes for fasteners (Subclause 5.2.4)

Replace the contents of Subclause 5.2.4.2 with the following:

"Holes for fasteners shall be drilled."

Replace the contents of Subclause 5.2.4.5 with the following:

"Punching of holes shall only be permitted with the written approval of the Engineer."

5.2.4 Welding in fabrication (New Subclause 5.2.7)

All welders shall be coded welders.

Welding procedures and welder's performance qualifications shall conform to the requirements of AWS D1.1 (and/or SANS 15614-1). These documents/certificates must be submitted in writing to the Engineer and approved prior to the start of welding. Welding certificates are only valid for a period of 12 months. The

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Contractor shall also submit, for review, an outline of the Quality Control measures that will be enforced by the Contractor to ensure that specified welding procedures are adhered to.

All welds shall be 6mm or larger continuous fillet welds, unless otherwise specified or agreed by the Engineer.

Welds shall be continuous on all sides of any joint. Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Crevices shall not be accepted.

No staggered or intermittent welding is permitted. Approved splicing of members will be subject to non-destructive testing. In addition, the Engineer may at his discretion identify any welds for non-destructive testing. The cost of testing shall be borne by the Contractor.

No welding on site is permitted unless approved by the Engineer. Any site welder and site welding procedure will have to be re-qualified for site welding.

5.3 ASSEMBLY (SUBCLAUSE 5.3)

5.3.1 Welding (Subclause 5.3.4)

Add the following to the end of the first sentence:

"The requirements of 5.2.7 shall apply."

5.3.2 Protective treatment (Subclause 5.3.9)

Replace the contents of this Subclause with the following:

"Corrosion protection for all structural steelwork shall be done in accordance with SANS 1200 HC."

5.4 ERECTION (SUBCLAUSE 5.5)

5.4.1 Anchor holes (New Subclause 5.5.6)

Drill bits used for creating anchor holes in concrete shall be incapable of cutting through reinforcing steel. The Contractor shall be responsible for accommodating the actual reinforcing positioning and avoiding reinforcing when drilling anchor holes. Any unused or discarded holes shall be cleaned and filled completely with the same chemical product approved for chemically anchoring the fasteners, unless an alternative product is approved. No additional payment shall be made for accommodating the reinforcing, including creating additional holes to achieve the required hole depths, filling unused holes, etc., which shall be included in the tendered price for steel items.

5.5 GROUTING OF SUPPORTS (SUBCLAUSE 5.6)

5.5.1 Holding-down bolts and grouting supports (New Subclause 5.6.5)

The Contractor shall supply detailed layouts of holding-down (HD) bolts, as well as a suitable steel template of each type of HD bolt layout which can be used to accurately position the bolts.

5.6 SUNDRY ITEMS (SUBCLAUSE 5.7)

5.6.1 Handrails (Subclause 5.7.1)

Replace the contents of this Subclause with the following:

"Handrails

5.7.1.1 The terms "handrailing", "handrails" and "guard rails" shall all be synonymous. Handrails shall be of the type and shall be purpose made in the style and shapes given in the project specification and indicated on the drawings. Steel tubing shall comply with SANS 657: Part 1. The Contractor shall ensure, by making in-situ measurements before manufacture is started, that the handrails suit the situation in which they are to be installed. Handrails shall have a vertical height of at least 1 000mm, measured from the top of the hand rail to the floor or surface. Where handrails terminate up against a wall or other barrier, the gap between the stanchion or closure bend (as applicable) and the barrier shall be less than 100mm, unless the rails are fixed directly to the barrier (removable handrailing may not be fixed directly to the barrier).

Handrailing shall be supplied by one manufacturer and in one fully integrated style, complete with

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of 1 500 Newtons is applied in a horizontal or downward direction to the secured guard chain.

5.7.1.5 Where kickplates are required, these shall be of the same material and receive the same coatings as the handrails (unless otherwise indicated) and provided along the full length of the handrailing system. Kickplates shall be at least 150mm high unless otherwise indicated, and fastened securely to the guard rails with M12 U-bolt fasteners. The top corners of kickplates shall be rounded to r=16mm.

For horizontal top mounted and removable handrailing, the kickplate shall be installed on the outside face of the handrailing (face furthest from the walkway centre). For horizontal side mounted handrailing, the kickplate shall be installed on the inside face of the handrailing.

At corners, kickplates shall be bent to suit the angle of the corner. Where kickplates meet, they shall overlap by 100mm, separated by a 150 x 100 x 1.5mm stiff solid neoprene (or similar approved) rubber strip and fastened together with 2 x M12 fasteners. These fasteners shall be orientated such that the bolt head ends of the fasteners point towards the centre of the walkway and ends with exposed threads point away from the walkway centre.

5.7.1.6 Should HDG handrailing be specified, the galvanizing shall be done in accordance with SANS 121 and SANS 10064, and all fabrication, sizing, modifying, drilling, cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising. Other corrosion protection systems or coatings specified shall comply with the general corrosion protection specification provided with the contract document.

5.7.1.7 All fasteners associated with handrailing shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 threads and the exposed fastener ends shall be free of sharp edges. The diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12 unless otherwise indicated. Washers shall be provided under the bolt head (as applicable) and nut.

Anchor fasteners for anchoring handrailing to concrete or brickwork shall be chemically anchored to the substrate with anchor depth of 140mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated, and no cutting of these fasteners will be permitted on Site. Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

5.7.1.8 Unless otherwise indicated on the drawings or in the Bill of Quantities, handrailing for public spaces shall also comply with the requirements above with the exception of those indicated in 5.7.1.3, 5.7.1.4 and 5.7.1.5. In addition, handrailing for public spaces shall comply with the requirements of SANS 10104 and no opening in handrailing installed in public places shall allow the passage of a ball of 100mm diameter.

5.6.2 Ladders (Subclause 5.7.2)

Replace the contents of this Subclause with the following:

"Ladders:

5.7.2.1 Ladders shall be manufactured in accordance with the details and general arrangements shown on the drawings. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings. Unless otherwise indicated, ladders and related ancillaries (threshold plates, grab bars, etc.) but excluding fasteners, shall be of stainless steel grade 316 material. Fasteners shall be of stainless steel grade 316 regardless of the ladder material specified.

5.7.2.2 All members shall be of solid structural sections (e.g. flat bar). Hollow sections are not acceptable

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all the necessary fasteners, connections, corrosion protection, coatings, etc. Handrailing shall, unless otherwise annotated on drawings, be continuous, uninterrupted at changes in direction or angle, i.e. rails shall not terminate and restart at changes in direction or angle but be continuously connected and joined with bends and stanchions formed to suit the changes.

Notwithstanding the above, at the interface between fixed and removable handrailing, rails and kickplates (if applicable) shall be discontinuous, with rails and kickplates ending at stanchions (rather than rails ending with closer bends/returns) and the required c/c spacing for these interfacing stanchions shall be 135mm.

Typically, the handrailing illustrated on drawings for each structure is exclusively for providing a high-level indication of where handrailing is necessary and for annotating (if applicable) the type required. The detailed handrailing requirements to be followed are provided on the general "Handrailing Details" drawing and in these specifications.

5.7.1.2 Unless otherwise indicated on the drawings or in the Bill of Quantities, the complete handrailing system (rails, stanchions, base plates, bends, kickplates, etc.) but excluding fasteners (which are specified elsewhere) shall be of stainless steel grade 316 material. The completed handrailing shall be of neat and workmanlike appearance, solidly and evenly supported, fastened in place, secure and tight under loading, true to line, level and plumb. Any gaps between stanchion base plates (stanchion feet) and concrete or brick surfaces shall be filled with non-shrink cementitious grout prior to final tightening of nuts. Where stanchion base plates are to be attached directly to metallic surfaces, Denso tape (or equivalent approved) shall be fitted under the stanchion feet to prevent direct contact.

Unless otherwise indicated, stanchions shall be top mounted (base mounted) to suit the arrangement requirements and shall be of welded construction. Stanchions which are hollow shall be self-draining. When anchoring top mounted stanchions to brickwork or concrete, they shall be installed with their centre line 100mm (unless otherwise indicated) from the edge of the platform or centred atop upstand beams or walls (as applicable). No stanchion shall be mounted with its centre closer than 300mm to a concrete or brickwork joint.

All handrailing joints, excluding kickplate joints which shall be bolted, shall be fully welded and smoothly finished without shoulders. Handrailing shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2mm.

5.7.1.3 Handrail stanchion spheres shall be preformed with orientation to suit the situation in and the angle at which they will be installed. Incorrectly orientated stanchion spheres will not be accepted. Stanchions shall be spaced at no greater than 1200mm centres for horizontal handrails and 1000mm centres for sloping handrails, unless otherwise indicated on the drawings or approved by the Engineer. Stanchions for a particular run shall be evenly spaced after first positioning those required at end and corners.

Railings shall be ended off with positively fixed closure bends/returns or by fixing directly to a wall or other barrier if appropriate and approved by the Engineer. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically manufactured for such a position shall be employed.

5.7.1.4 At certain positions where it shall be necessary to have infrequent access to parts of the works which shall normally be equipped with handrails, the Engineer may instruct that handrails over these short sections be omitted in favour of guard chains. A guard chain shall consist of a 6mm diameter stainless steel grade 304 chain secured across stanchions with an M8 hook bolt on one end and an M8 eye bolt on the other. The bolts shall be fastened tightly to the stanchions and it shall only be possible to unhook the chain at one end. If alternative hook designs are approved by the Engineer, these hooks shall not be damaged nor undergo noticeable deflection when a point load

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for any part of the ladder.

All rungs in a flight shall be uniformly spaced at 250mm centres (unless otherwise indicated) after positioning the rung nearest the upper platform (or threshold platform, as applicable) in the position shown on the drawings. A minimum clear space of 230mm shall be provided behind the rungs, unless otherwise indicated on the drawings.

Anchoring supports (mounting brackets) shall be uniformly spaced at a distance not exceeding 2m. When mounted to concrete or brickwork, the gap between anchoring supports and the substrate to which they affix shall be no greater than 15mm, and any gaps between them shall be filled with flowable non-shrink cementitious grout after the supports have been secured in place prior to final tightening of the nuts. Where ladders are mounted to steel surfaces, no gap shall be left between the surface and the anchoring support, and Denso Tape or approved equivalent shall be fitted under the anchoring support feet to completely seal the crevices between the two metallic surfaces.

Where the strings (also referred to as stringers) extend above an upper landing, they shall complement any handrailing at this level. Ladder-to-handrailing connections shall be bolted.

Generally, and unless otherwise indicated on drawings or in the BOQ, ladders of height greater than 5m and up to 10m shall be provided with cages. No part of the cage shall be more than 700mm away from the plane of the rungs.

5.7.2.3 All joints shall be fully welded (leaving no crevices) and smoothly finished without shoulders. Ladders shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2mm. Sharp edges, pits, inclusions, weld spatter, undercuts, indentations and other surface defects are not acceptable. Stainless steel ladders shall be pickled and passivated prior to installation.

If HDG ladders are specified, they shall be hot-dip galvanised after all fabrication has been completed. The unit shall be blasted and re-galvanised if it is welded, drilled or ground after galvanizing or if the zinc layer is damaged.

5.7.2.4 If a ladder as a single unit is excessively long, for ease of handling and transporting, the ladder may (at the discretion of the engineer) be divided into practical portable lengths and reassembled on Site. Should the ladder be divided, jointing fishplates will be required (500 x 65 x 10 for the stringer joints and 500 x 45 x 8 for caging joint) and shall be located on the outside of the ladder user area with 6 No M12 countersunk bolts on the inside of the same area (3 No equally spaced on both sides of the joint). Any costs for dividing the ladder shall not be paid for separately, but shall be taken to be included in the rate tendered for the ladder.

5.7.2.5 The Contractor shall make arrangements for the Engineer to inspect the fabricated ladders for compliance prior to installation. Only ladders that comply shall be installed.

5.7.2.6 Ladders shall be supplied complete with all the necessary fasteners, etc. for fixing. All fasteners associated with ladders shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 thread and the exposed fastener end shall be free of sharp edges. Unless otherwise indicated, the diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12. Washers shall be provided under bolt heads (as applicable) and nuts.

Unless otherwise indicated, fasteners for anchoring the ladder and ancillaries to concrete or brickwork shall be chemically anchored to the substrate with an anchor depth of 140mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on site). Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

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5.6.3 Open grid floors (Subclause 5.7.3)

Replace the contents of this Subclause with the following:

"Steel Open Grid Floors

5.7.3.1 The term "grating" shall be synonymous with "grid flooring". Open grid flooring panels (whether or not they are covered with a vastrap or similar plate) shall be manufactured by an approved firm specializing in such work. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings.

5.7.3.2 The grid flooring depth as well as the thickness and pitch (spacing) of both bearer bars and transverse bars shall be as specified on the drawing. Unless otherwise indicated, bearer bars shall run parallel to shorter span (bearer bars to run between closest supports).

Grid flooring shall be manufactured with transverse bars permanently locked to bearer bars (i.e. compressive pressure locked or welded or both, unless otherwise indicated). Grid flooring panels shall be banded around all edges, including edges of cut-outs and removable or hinged access covers. These bands shall be of equal height and thickness to the bearer bars and shall be fully welded to the flooring panel (leaving no crevices at joints).

5.7.3.3 The panels shall be supplied prefabricated with cut-outs given on the details and those necessary to accommodate the Contractor's equipment. Cut-outs made to accommodate equipment shall be neat and as small as practical and gaps between equipment and grid flooring shall not exceeding 100mm in extreme cases. Panels/off-cuts may not be welded together to create larger panels.

Unless otherwise specified, cutting of grating with top covers shall be done at angles and curves to suit the equipment. For grating without top covers, cutting shall generally be done parallel or perpendicular to bearer bars (as applicable), except for cut-outs made to accommodate circular objects or pipes larger than DN 300 where the cut-out shall instead be circular to prevent excessive gaps between the object and sides of the cut-out. Unless authorized to do so, the Contractor shall not cut or weld grid floor panels on Site.

5.7.3.4 The gap between the edge of grid flooring and the support frame or abutting structure (as applicable) shall be at least 2mm and no greater than 10mm on each side (or no greater than 20mm on one side when the panel is shifted up against the support frame/abutting structure on the opposite side). No gaps shall be left between adjacent panels.

Grid flooring shall be mounted firm and level (unless the surrounding floor has a fall, in which case the grating shall match this fall) orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Adjacent floor panels shall have vertical edge alignment of within 3mm of each other. A least four fixing clip sets of the appropriate types (depending on the location being secured) shall be used to secure each panel to the supports and adjacent panels. No perceptible movement or rocking will be acceptable. Fixing clip sets shall be stainless steel grade 316 with M8 or larger fasteners, of standard types (i.e. M-Type, F-Type, G-Type, etc.) and approved by the grid flooring manufacturer.

Individual panel lengths (measured parallel to the bearer bars) shall be no greater than 2.4m. Unless otherwise approved, individual panels which are not supported along their entire perimeter shall be no less than 1m wide at the narrowest section (where the width is measured at right angles to the bearer bars), except for the final panel in a series of panels where a smaller width may be needed to close the remaining opening. Where narrower widths are specified or approved, each unsupported panel edge shall be fixed with clip sets to the adjacent flooring panel at 350mm centre or with a minimum of 2 clip sets, whichever is greater (these over and above the four fixing clip sets aforementioned).

5.7.3.5 Where vastrap plate flooring covers are required, they shall cover the entire top of the grid flooring

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panel (with the edges of the vastrap plate flush with the edges of the flooring panel) and shall be welded to the panel with 20 to 30mm welds at 300mm centres. Stainless steel grade 316 countersunk bolts shall be used with clip sets to secure flooring panels which are covered with vastrap plates to supports and to each other. Suitably positioned countersunk bolt holes shall be made in the vastrap plates prior to them being HDG (if HDG is applicable). The countersunk bolts shall not protrude above the vastrap plate beyond the height of the tread pattern.

5.7.3.6 The angle supports (also referred to as frames) indicated on drawings (including added flat bars where required) are to be installed continuously along the full perimeters of openings which are to be covered with flooring panels. Notwithstanding the above, where the support frame crosses a concrete or brickwork joint, the joint is to be extended through the angle frame.

Where two different angle support types (flooring details) are specified for supporting one area of flooring, the cast-in angle support type shall be used wherever possible, with the bolt-on angle support type only used where the cast-in angle support cannot be used.

Where a structural member is to pass through a flooring panel, adequately sized bolt-on angle supports shall be installed around and fastened to the circumference of the structural member to support the flooring panel, unless otherwise directed by the Engineer. All angle supports will not be paid for separately but shall be included in the rate tendered for the relevant flooring panels.

5.7.3.7 Additional support systems which exclude angle supports and top hat sections (thus I-beams and channels, etc. are additional supports) may be specified on drawings. Each support type, complete with end plates, flat bars, fasteners, etc. will be scheduled and paid for separately under 8.3.1. The grid flooring shall be fabricated to suit the additional supports.

Unless otherwise indicated, additional supports that cross from one side of an opening to the opposite side (i.e. a straight support beam) shall be orientated such that each runs parallel to the shorter span (i.e. for a channel, they shall run between the nearest channel walls).

Where a cut-out in the flooring larger than 480mm in width or diameter (irrespective of whether the cut-out bridges more than one panel) is necessary to accommodate an object(s) passing through the flooring (which objects are not designed to structurally support the flooring, i.e. pipes and equipment), these additional supports shall first be placed as close as practical on either side of the object. The remaining supports shall be evenly spaced with appropriate centres that fall within the spacing range indicated on the drawings (or at specific centres if so specified).

Notwithstanding the above, the additional supports shall be suitably positioned to prevent more than 50% of the bearer bars of a single panel being cut in the event of multiple cut-outs being required in the same panel. Where this is unavoidable, suitable alternative support designs shall be submitted by the Contractor to the Engineer for approval.

The gap between additional support ends and the substrates to which they affix shall be no greater than 10mm, and this gap shall be neatly filled with flowable non-shrink cementitious grout after the supports have been secured in place and prior to final tightening of nuts. Additional supports shall not be mounted over or with the centreline within 200mm of a concrete or brickwork joint.

5.7.3.8 The Contractor shall submit for approval all relevant details for additional cut-outs and supports to flooring which are not specified but are required by him to accommodate his equipment. These flooring modifications and supports shall ensure that, while under design load conditions, the deflection of any bearer bars does not exceed 1/200th of the clear span, or 10mm, whichever is the lesser. Any approved modifications shall be done prior to HDG. Cut-outs and supports required by the Contractor will not be measured or paid for separately but shall be included in the rate tendered for the relevant flooring panels.

5.7.3.9 Unless otherwise indicated, all joints to be fully welded with no crevices. All steel items, excluding fasteners, handles, hinges and clip sets, shall be HDG unless otherwise indicated. HDG shall be done in accordance with SANS 121 and SANS 10064. All fabrication, sizing, modifying, drilling,

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cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising.

5.7.3.10 All fasteners shall be of stainless steel grade 316, unless otherwise specified. Fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on Site). Anchor fasteners shall be chemically anchored into concrete or brickwork using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). The anchor holes required shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive or fastener. SS316 washers shall be provided under both bolt head (where applicable) and nut. Unless otherwise approved, fastener threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed.

6 TOLERANCES (CLAUSE 6)

No amendments.

7 TESTING (CLAUSE 7)

7.1 TEST CERTIFICATES (SUBCLAUSE 7.1)

Add the following:

"Test certificates pertaining to steel used for the various members shall be supplied by the Contractor to the Engineer when requested."

7.2 WELDING TESTING (NEW SUBCLAUSE 7.4)

All non-destructive testing procedures, techniques and acceptance criteria shall be in accordance with AWS D1.1 (and/or SANS 15614-1) and certificates of all testing shall be submitted to the Engineer. Personnel performing non-destructive testing (other than visual) shall be qualified in accordance with the stipulations of the code. All non-destructive examinations shall be carried out in accordance with written procedures approved by the Engineer .

Full penetration butt welds are to be radio graphically tested in accordance with AWS D1.1 (and/or SANS 15614-1). A minimum of 50% of full penetration welds shall be tested. If more than 5% of the examined welds show unsatisfactory results, then additional examinations covering all welds shall be performed. Fillet welds will be inspected and tested to AWS D1.1 (and/or SANS 15614-1) at the discretion of the Engineer. Ultrasonic and radiographic examinations shall not be made within the period of 24 hours after completion of welding.

All costs (time, travelling, testing etc.) incurred by non-destructive examinations (whether due to non-conformance of specifications, any latent defects in material and welding, or as requested by the Engineer) shall be borne by the Contractor.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

Add the following to the end of this Subclause:

"8.1.3 The tendered price for steel items includes for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified. These listed items will not be measured separately."

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.3)

Delete Subclauses 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.3.6 *and 8.3.13 and substitute with the following:*

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"8.3.1 Structural steel .....Unit: t or No

The rate shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified.

The supply and fixing of roof sheeting, cladding and rainwater goods shall be scheduled separately."

8.2.1 Handrails (Subclause 8.3.7)

Replace the contents of this Subclause with the following:

Handrail assembly complete (drawing number stated/details given):

a) Horizontal top mounted.....Unit: m
b) Horizontal side mounted flush .....Unit: m
c) Horizontal side mounted offset .....Unit: m
d) Horizontal removable .....Unit: m
e) Sloping top mounted.....Unit: m
f) Sloping angle mounted .....Unit: m
g) Sloping side mounted flush.....Unit: m
h) Step ladders top mounted.....Unit: m
i) Step ladders side mounted flush .....Unit: m
j) Bends.....Unit: No.
k) End closures .....Unit: No.
l) Sleeves for removable stanchions.....Unit: No.
m) Kickplates.....Unit: m
n) Handrailing for public places.....Unit: Sum or m
o) Guard chains.....Unit: No

The per-meter rates (a) through (i), shall be per meter of handrailing assembly complete. The per-number rates (j) through (l) shall be extra over to the relevant per meter rate (a) through (i). The rate for bends shall be 1 No. per change in handrailing direction/angle (i.e. a bend in the handrailing shall typically incorporate a bend in both the hand rail and a knee rail, which shall together be measured as 1 bend). The per-meter rate for kickplates shall be per meter of kickplate assembly complete. The rate for handrailing in public places shall be for the complete assembly as indicated, or per meter of the type indicated. The per-number rate for guard chains shall be the number of each guard chain assembly complete, separated for different guard chain details and for each width (or range of widths) between substrates (stanchions/walls/stringers, as applicable) to which the guard chain eye and hook bolts will be affixed.

The tendered rates shall include for the production of shop drawings/details (where required), all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the handrails, kickplates, guard rails, etc., including grouting in/fixing to concrete, brickwork, steel substrates, etc. as shown on drawings and as specified."

8.2.2 Ladders, complete and installed (Subclause 8.3.8)

*In the heading, replace the word "*length*" with the word "*height*".*

Replace the contents of this Subclause with the following:

"Separate items will be scheduled for ladders of different types and heights (or height ranges). The height shall be measured as the vertical distance between the two levels which the ladder provides access between (i.e. the distance between the upper and lower levels connected by the ladder).

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The rate for ladders shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the ladders, including fixing it to the concrete, brickwork, etc. as shown on drawings or as specified.

The rate shall also include for all ladder ancillaries shown on the ladder drawings such as threshold plates, grab bars, etc.

8.2.3 Flooring, complete and installed with frames (Subclause 8.3.9)

Replace the contents of this Subclause with the following:

The rate shall cover the cost of supplying the specified or scheduled type of flooring complete with angle supports/frames (including added flat bars where required) and top hat sections as indicated on the drawings and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of shop drawings/details (where required), all procurement costs, fabrication, cutting, welding, banding, cut-outs, corrosion protection (including galvanizing, painting, etc.) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including fasteners, clips, etc.) necessary for proper completion of the flooring and support frames.

Any additional supports and cut-outs not specified but which are required by the Contractor to accommodate his equipment layout shall not be paid for separately, but shall be included for in the above rate for flooring.

Additional support systems specified (i.e. specified i-beams and channel sections) will be scheduled and paid for separately under 8.3.1, which rate shall also include for the required end connections, flat bars, fasteners, etc. Additional support systems exclude angle support/frames, etc. which are already included for under the rate for flooring.

8.2.4 Miscellaneous steel items (New Subclause 8.3.14)

a) Items measured by area:
Description of or drawings reference to item ..... Unit: square metre (m^2)

b) Items measured by length:
Description of or drawings reference to item ..... Unit: metre (m)

c) Items measured by number:
Description of or drawings reference to item ..... Unit: No

d) Items measured by mass:
Description of or drawings reference to item ..... Unit: kg or ton

The unit of measurement shall be the square metre, linear meter, number or mass as applicable to each item. The tendered rates shall include full compensation for all labour, materials, fasteners (including holding-down bolts), plant, equipment, transport, etc, manufacturing or providing and installing each item complete as scheduled and shown on the Drawings, and shall include all corrosion protection, finishes and inspections as per Subclause 7.2 of SANS 1200 HC, where applicable.

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1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATIONS (CLAUSE 2)

No Amendments.

3 MATERIALS (CLAUSE 3)

3.1 THICKNESS OF SHEETING (SUBCLAUSE 3.1)

Replace "The thickness of the sheeting" *with* "Unless specified elsewhere in Clause 3, or specified on the Drawings or in the Bill of Quantities, the thickness of the sheeting".

3.2 STEEL SHEETING (SUBCLAUSE 3.2)

3.2.1 Galvanized Steel Sheeting (Subclause 3.2.1)

Replace "galvanizing shall comply with" *with* "galvanizing shall, unless otherwise specified, comply with"

3.2.2 Prepainted Galvanized Steel Sheeting (Subclause 3.2.1)

Replace "galvanizing shall comply with" *with* "galvanizing shall, unless otherwise specified, comply with"

3.2.3 Proprietary steel sheeting (New Subclause 3.2.4)

Proprietary steel roof sheeting and cladding specified on the drawings or in the Bill of Quantities shall be provided with a certificate verifying material compliance and be clearly marked on the reverse side at one-meter intervals indicating thickness, material quality, coating thickness and paint system. The proprietary roof sheeting and cladding provided shall have a successful record (of 5 years minimum) of use in similar applications locally. In addition, the proprietary roof sheeting and cladding shall comply with the following requirements:

a) 0.54mm Safintra NEWLOK Bluescope Clean COLORBOND ULTRA AZ200 (or similar approved): 0.54mm thick Safintra NEWLOK concealed fix, standing seem, Aluminium-Zinc coated (AZ200) Grade G550 steel roofing (minimum yield strength 550 MPa), with Bluescope Clean COLORBOND ULTRA proprietary system both sides and including touching-up cut and slit edges ("Enduring White" colour if no colour is specified on the drawings). Sheeting profile to have an effective cover width of 445mm and rib height of 50.8mm and roll-formed to full required lengths (continuous lengths without lap), complete with NEWLOK aluminium clips fixed to purlins (through over-purlin insulation if applicable) with Safintra approved stainless steel 316 wafer head fasteners, all strictly in accordance with manufacturer's specifications. The compleie roofing system shali be provided with a 10-year guarantee, and shall be inspected and approved in writing by the supplier after installation.

3.3 ALUMINIUM SHEETING (SUBCLAUSE 3.3)

3.3.1 Proprietary aluminium sheeting (New Subclause 3.3.3)

Proprietary aluminium roof sheeting and cladding specified on the drawings or in the Bill of Quantities shall be provided with a certificate verifying material compliance and be clearly marked on the reverse side at one-meter intervals indicating thickness, material quality, coating thickness and paint system. The proprietary roof sheeting and cladding provided shall have a successful record (of 5 years minimum) of use in similar applications locally. In addition, the proprietary roof sheeting and cladding shall comply with the following requirements:

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a) 0.8mm Aluminium Safintra NEWLOK Color-Tech PVDF (or similar approved): 0.80mm thick Safintra NEWLOK concealed fix, standing seem, Aluminium (Alloy 3004) roofing, pre-painted both sides with Color-Tech PVDF (colour as stated in Bill of Quantities or on drawings), with an effective cover width of 445mm and rib height of 50.8mm, roll-formed to full required lengths (continuous lengths without lap), complete with 2k Polyurethane coated NEWLOK aluminium clips fixed to purlins (through over-purlin insulation if applicable) with Safintra approved stainless steel 316 wafer head fasteners, all strictly in accordance with manufacturer's specifications. The complete roofing system shall be provided with a 10-year guarantee, and shall be inspected and approved in writing by the supplier after installation.

3.4 FASTENERS (SUBCLAUSE 3.7)

3.4.1 General (Subclause 3.7.1)

Add the following to the end of this Subclause:

"Fasteners for cladding, sheeting, ridge capping, flashings, etc. shall be in strict accordance with the manufacturer's specifications, taking into account high wind loads and severe corrosion conditions with proximity to the sea. Where the cladding, sheeting, ridge capping, flashings, etc. are stainless steel or aluminium, the fasteners shall be stainless steel grade 316 and otherwise in strict accordance with the manufacturer's specifications."

3.5 RAINWATER GOODS (SUBCLAUSE 3.8)

Add the following:

"Unless otherwise indicated on Drawings or Bill of Quantities, rainwater goods shall be manufactured from aluminium and finished in a colour to match the cladding and roof sheeting."

3.6 FLASHINGS AND RIDGE CAPPING (NEW SUBCLAUSE 3.11)

Flashings and ridge capping shall be manufactured from the same material and have the same corrosion protection and finish as the roof sheeting and cladding, and the thickness shall, unless otherwise specified on the Drawings or in the Bill of Quantities, be at least the thickness of the roof sheeting and cladding.

4 PLANT (CLAUSE 4)

No Amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 RESPONSIBILITY (SUBCLAUSE 5.1)

5.1.1 Installation Details (Subclause 5.1.4)

Replace the first sentence of this subclause with the following:

"The Contractor shall be solely responsible for ensuring that materials and installation of cladding, sheeting, ridge capping, flashings, etc. comply with the manufacturer's specifications, the project specifications, Engineer's drawings of the general arrangement and details and, subject to Engineer's approval, the Contractor's additional detail drawings."

5.2 INSTALLATION OF SHEETING (SUBCLAUSE 5.5)

Add the following to the end of this Subclause:

"Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site."

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5.3 FLASHINGS (SUBCLAUSE 5.6)

Add the following to the end of this Subclause:

"Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site."

5.4 PROTRUSIONS THROUGH SHEETED SURFACES (SUBCLAUSE 5.7)

Add the following to the end of this Subclause:

"Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site."

5.5 DETAIL DRAWINGS (NEW SUBCLAUSE 5.8)

The Contractor shall be responsible for preparing drawings of all sheeting/flashing/insulation details required (including details of the fasteners which he proposes to use). The drawings shall be submitted for approval at least two weeks prior to commencement of fabrication.

The Engineer shall require seven working days for the approval of the detail drawings submitted by the Contractor. No sheeting work shall be permitted to commence until such time as the detail drawings have been approved.

6 TOLERANCES (CLAUSE 6)

6.1 INSTALLATION (SUBCLAUSE 6.2)

6.1.1 Sheeting and cladding (Subclause 6.2.2)

Add the following:

"The maximum deviation from the theoretical position of sheeting/flashing lines shall be ±5mm.

The maximum deviation from the straightness of sheeting/flashing lines or abrupt change in same shall be 3mm. the deviation shall be measured as the maximum deviation of the surface from any straight line of length 3mm joining two points on the surface, determined by means of a straight edge, the ends of which are supported on identical blocks of suitable thickness placed over each of the points."

7 TESTING (CLAUSE 7)

No Amendments.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Supply and install cladding and sheeting (Subclause 8.2.2)

Add the following:

"The rate tendered shall also cover the cost of corrosion protection and/or coloured finish (i.e painting) as specified, required clips, insulating tape and washers (if applicable), and all plant, labour and material necessary for proper completion of the work, as well as the provision of detailed drawings required in terms of 5.8."

8.1.2 Supply and install ancillaries (Subclause 8.2.3)

Add the following:

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"The rate tendered shall also cover the cost of corrosion protection and/or coloured finish (i.e. painting) as specified, required clips, insulating tape and washers (if applicable), and all plant, labour and material necessary for proper completion of the work, as well as the provision of detailed drawings required in terms of 5.8."

8.1.3 Painting (Subclause 8.2.4)

Delete this Subclause.

Painting and corrosion protection of cladding, sheeting and ancillaries is already included for under their respective rates.

8.1.4 Supply and install insulation (New Subclause 8.2.6)

The unit of measurement shall be the square meter of area covered by the insulation (or insulation system) installed, with no deduction being made for protrusions or areas covered by overlaps.

The rate tendered shall cover the cost of the supply, delivery, installation and fixing of insulation as well as all the plant, labour and material necessary for proper completion of the work, including all straining wires and/or other supports.

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[redacted]

1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS AND ABBREVIATIONS (SUBCLAUSE 2.3)

Add the following to the end of this subclause:

"or hot dip galvanized (as applicable)"

3 MATERIALS (CLAUSE 3)

3.1 STAINLESS STEEL (NEW SUBCLAUSE 3.4)

All stainless steel shall be pickled and passivated after manufacture and all heat tint, weld splatter and impurities introduced by grinding, cutting etc. are to be removed. Passivation shall be in an approximate 15 percent solution by mass of nitric acid, at 60 degrees Celsius, for 20 to 30 minutes. Before passivation, the equipment shall be thoroughly cleaned and all traces of oil and other contaminants removed. The equipment shall be washed thoroughly after passivation.

Only descaled steel shall be used.

3.2 INSULATION (NEW SUBCLAUSE 3.5)

Where different metals are fastened together, such as mild steel and stainless steel, a non-porous insulator shall be inserted in the joint to prevent direct contact of the metals.

3.3 PROCUREMENT OF PAINT (NEW SUBCLAUSE 3.6)

The Contractor shall provide the Engineer with details of the paints he intends on using, including the manufacturer's data sheets for each product and shall only proceed with the purchase of the paints upon receipt of written approval from the Engineer.

All materials in a paint system shall be purchased from one supplier. The Contractor shall provide the paint supplier with a copy of the relevant sections of the Specification. The Contractor shall obtain a certificate from the paint supplier certifying that the materials to be supplied comply with the relevant Specification and are suitable for the intended purpose.

No variation in brand or material from those quoted in the tender documents and/or as approved by the Engineer shall be permitted without the approval of the Engineer in writing.

Any conflict between the manufacturer's data sheet and the Specification shall be referred to the Engineer for adjudication

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 COATING SYSTEM (SUBCLAUSE 5.7)

Replace the contents of this Subclause with the following:

"The coating system shall be as indicated in the following table:

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Location	Structural/mild steel elements	Coating system
Muldersvlei Reservoir Site	All structural steelwork in Chlorine OSEC Building	Duplex coating system, as per Subclause 5.12
Muldersvlei Reservoir Site	Handrails, ladders, open grid flooring	as per SANS 1200H Subclause 5.7

5.2 APPLICATION OF PAINT COATINGS (SUBCLAUSE 5.8)

Add the following at the end of this Subclause:

"All paintwork shall be executed by tradesmen skilled in this class of work, and in strict accordance with the manufacturer's recommendations as approved.

All surfaces which cannot be painted after erection shall be painted as specified herein before erection."

5.3 APPLICATION OF METAL COATINGS (SUBCLAUSE 5.9)

Add the following at the end of this Subclause:

"Hot-dip galvanized material which is to remain unpainted shall be passivated as specified in SANS 121. Items to be painted after hot-dip galvanizing shall be air dried and not passivated."

5.4 REPAIR OF DAMAGED COATINGS (SUBCLAUSE 5.10)

Add the following at the end of this Subclause:

"Unless otherwise approved by the Engineer, items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising."

5.5 SURFACE PREPARATION (NEW SUBCLAUSE 5.11)

5.5.1 General (New Subclause 5.11.1)

All items to be corrosion protected shall be tested and inspected for compliance with the applicable Specifications before any cleaning of the surface is commenced.

All surfaces to be corrosion protected shall be degreased prior to any other method of surface preparation.

The area affected by weld heating shall be polished by means of plastic abrading pads until free of discolourations, and subsequently thoroughly degreased using a water rinseable detergent and allowed to dry.

5.6 DUPLEX COATING SYSTEM (NEW SUBCLAUSE 5.12)

A duplex system of coating shall consist of firstly hot-dip galvanizing the steel, followed by an organic coating.

Fabrication of items to receive a duplex system shall be in accordance with SANS 14713. HDG shall be done in accordance with SANS 121 and coatings shall be to the thicknesses detailed in the Standard.

After HDG, the items shall be air dried and not passivated as these items are to be painted.

Preparation and application of organic coatings on HDG shall be done in accordance with the Hot Dip Galvanizers Association of Southern Africa's Code of Practice for Surface Preparation and Application of Organic Coatings.

The duplex system shall comply with the following:

a) Hot-dip galvanized, as specified above, without passivation of the zinc coating.

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b) Application of one coat of an epoxy primer (two part; for hot-dip galvanized surfaces) with a dry film thickness (DFT) of 75µm.

c) Polyurethane enamel top coat (two part) with a DFT of 50µm; done at the factory after suitable repair to the primer.

d) Touch up repairs on site after erection.

Refer to 5.8 for application of paint coatings.

6 TOLERANCES (CLAUSE 6)

6.1 DRY FILM THICKNESS (SUBCLAUSE 6.5)

Delete the first two sentences of this Subclause.

6.1.1 Individual coatings (New Subclause 6.5.1)

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no individual reading shall be less than 70% of the specified minimum thickness.

6.1.2 Total dry film thickness (New Subclause 6.5.2)

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For immersion conditions no reading shall exceed the mean specified thickness by greater than 60% of the minimum, unless a concession is granted by the Engineer.

7 TESTING (CLAUSE 7)

7.1 INSPECTION BY ENGINEER (SUBCLAUSE 7.2)

Replace the heading of Subclause 7.2 with "Inspections".

Replace the contents of Subclause 7.2 with the following:

"7.2.1 Inspection by Engineer

Inspection by the Engineer (or his representative) will be carried out timeously. The inspector shall be given reasonable advance notice of the availability of steel for inspection.

The Contractor shall make arrangements for the inspector to inspect the items at the following stages:

a) On completion of fabrication and before HDG.

b) After HDG and before priming.

c) After priming.

d) After top coat but before dispatch to site.

7.2.2 Independent Inspectorate

The Contractor shall nominate an independent inspectorate to carry out any tests to verify compliance with the corrosion protection Specifications.

The Inspectorate shall inspect the work to verify that at least the following are in accordance with the Specifications:

a) Surface preparation prior to painting,

b) Coating thicknesses,

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[redacted]

c) Holiday testing, and

d) Paint quality, type and method of application.

The Contractor shall:

i) Draw up a quality control programme together with the independent inspectorate,

ii) Contact the inspectorate timeously to make arrangements for him to inspect the various items to be tested both prior to and after painting or HDG,

iii) Submit copies of the quality control programme to the Engineer, and

iv) Submit all the inspectorate's reports to the Engineer."

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 PRINCIPLES (SUBCLAUSE 8.1)

Replace Subclause 8.1 with the following:

"Unless otherwise indicated, corrosion protection shall not be measured and paid for separately, and rates and sums tendered for steel items under Subclause 8.3 of SANS 1200 H shall include all costs related to corrosion protection (inclusive of all costs related to 8.2 below).

Measurement and payment for items as detailed under 8.2 shall only be applicable for steel items not provided by the Contractor, unless otherwise indicated."

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.2.1 **Inspection by the** Engineer **(New Subclause 8.2.5)**

Where scheduled for a steel item, the unit of measure shall be as scheduled and the rate or sum shall cover all costs associated with 7.2.1.

8.2.2 Independent Inspectorate (New Subclause 8.2.6)

Where scheduled for a steel item, the unit of measure shall be as scheduled and the rate or sum shall cover all costs associated with 7.2.2.

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1 SCOPE (CLAUSE 1)

Add the following:

"For the manufacture, laying, jointing and corrosion protection requirements of bulk steel pipes and pipe specials requiring cement mortar lining and sheathing, refer to the applicable Particular Specifications listed under C3.7.5 and the associated amendments under C3.7.6."

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITION (SUBCLAUSE 2.3)

Amend the definition for "special" as follows:

"Special. Any pipe other than a straight section of pipe but including puddle pipes.
NOTE: Under this definition are included all sizes of specials such as bends, tees, crosses, angle branches, reducers, tapers and puddle pipes."

Add the following definition:

"Maximum design pressure. The pressure rating or pressure class of the pipe material unless otherwise specified in the Project Specification, or shown on the drawings."

2.2 ABBREVIATIONS (SUBCLAUSE 2.4)

Add the following to the list of abbreviations:

"MS : Mild Steel

DN : Nominal Diameter

GRP : Glass fibre Reinforced Plastic (synonymous with FRP)

HDG : Hot Dip Galvanised (steel substrate)

HDPE : High-density Polyethylene

PVC-M : Modified Poly Vinyl Chloride

PVC-U : Unplasticised Poly Vinyl Chloride (synonymous with uPVC)

SS : Stainless Steel"

3 MATERIALS (CLAUSE 3)

3.1 STEEL PIPES, FITTINGS AND SPECIALS (SUBCLAUSE 3.4)

Delete the contents of this clause and replace with the following: "Steel pipes shall comply with Particular Specification SPE-MP-7002 and its amendments. Steel fittings and specials shall comply with Particular Specification SPE-MP-7001 and its amendment".

3.2 OTHER TYPES OF PIPES (SUBCLAUSE 3.7)

3.2.1 uPVC pipes (Subclause 3.7.1)

In the heading of this Subclause, replace "uPVC" with "PVC-U".

Replace the contents of this Subclause with the following:

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"PVC-U (also referred to as uPVC in this spec) pipes shall comply with the requirements of SANS 966. All PVC-U pipes shall be PN 12 unless otherwise specified or shown on the drawings.

Bends on PVC-U for DN 250 and smaller shall be manufactured from PVC-U. Bends on PVC pipes larger than DN 250 shall be manufactured from cast iron or ductile iron. All other specials on PVC-U pipes shall be manufactured from cast iron, ductile iron, and Grade 316L stainless steel, based on the detail of the special."

3.2.2 Polyethylene pipes (Subclause 3.7.2)

Replace the contents of this Subclause with the following:

"High density polyethylene (HDPE) pipes and specials shall all be of material PE100 and comply with the requirements of SANS ISO 4427.

Where HDPE pipes and specials are not manufactured by a SAPPMA member, the approval of the manufacturer shall be obtained from the Employer's Agent prior to ordering any pipes or specials.

The Contractor shall provide the Employer's Agent with the batch release test results from the raw material supplier for each pipe diameter and pressure class. The following shall be considered the minimum requirements: compound density, carbon black content, volatile content, oxidation induction time and melt mass flow rate.

The Contractor shall also submit samples taken from the manufactured pipes for testing at an independent test facility where the following shall be tested as the minimum requirements: compound density, carbon black content, carbon black dispersion, volatile content, oxidation induction time, melt mass flow rate and elongation at break. Test shall be performed on each pipe diameter and pressure class applicable to the contract."

3.3 JOINTING MATERIALS (SUBCLAUSE 3.8)

3.3.1 Flexible Couplings (Subclause 3.8.2)

Replace the contents if this subclause with the following:

"Flexible couplings shall be in accordance with Particular Specification W&S-BW-10 and its amendments.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed.

Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings."

3.3.2 Flanges and Accessories (Subclause 3.8.3)

Replace the contents of this subclause with the following:

"Flanges shall comply with the requirements of Particular Specifications SPE-MP-7001 and SPE-MP-7002 and their amendments. Each flanged pipe and fitting shall be supplied complete with one set of bolts, nuts, gaskets in compliance with the specifications.

Unless otherwise specified, gaskets shall be full faced and of a material and thickness suitable for the application."

3.3.3 Loose flanges (Subclause 3.8.4)

Replace the contents of this subclause with the following:

"Loose flanges supplied on this contract shall comply with the flange specifications included for steel pipes and specials in SPE-MP-7002 and SPE-MP-7001 respectively. The length of each bolt shall be such that the bolt threads project no less than 1 thread and no more than 8 threads above the head of the nut.

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Backing ring flanges for HDPE pipes and fittings shall be in accordance with SANS 1123 and be manufactured from grade 316 stainless steel, unless otherwise shown on the drawings or specified in the Bill of Quantities."

Add the following new subclauses:

3.3.4 Joining pipes/fittings of the same material (New Subclause 3.8.8)

a) HDPE pipes shall be joined by means of butt fusion welding. HDPE pipes of DN 110 and smaller can be joined with compression type fittings. Electro-fusion fittings will not be accepted unless approved by the Employer's Agent.

b) PVC-U / PVC-M pipes shall use push in joints. The pipe end shall be spigot and socket with integral socket and locked-in rubber ring seal, unless otherwise shown on the drawings.

3.3.5 Joining pipes/fittings of different materials (New Subclause 3.8.9)

a) Unless otherwise specified on the drawings or in the Bill of Quantities, when connecting HDPE pipes to pipes or fittings of other materials, they shall be bolted together. The HDPE pipe shall have a stub and steel backing ring (SS316 backing ring unless otherwise specified) and the adjoining pipe or fitting of other material shall be flanged. Attempting to join plain-ended HDPE pipes to pipes and fittings of other materials will not be accepted.

b) Unless otherwise specified on the drawings or in the Bill of Quantities, when connecting PVC-U/PVC-M pipes to pipes or fittings of other materials, this shall be done by means of a flange adapter. The PVC pipe shall be fitted with a ductile or cast iron flange adapter with socket end and the adjoining pipe or fitting of other material shall be flanged. An insulating flange shall be provided to prevent bi-metallic corrosion between the steel flange and the flange adaptor, and the flanges shall be bolted together.

3.3.6 Pipe Supports (New Subclause 3.8.10)

Pipe supports shall be in accordance with Particular Specification SPE-MP-7024 and its amendments."

3.4 CORROSION PROTECTION (SUBCLAUSE 3.9)

3.4.1 Steel Pipes (Subclause 3.9.2)

Replace the contents of this subclause with the following:

"Corrosion protection of steel pipes and pipe specials shall be in accordance with Particular Specification SPE-JJ-0003 and its amendments."

3.4.2 Flexible Couplings (Subclause 3.9.4)

Replace the contents of this subclause with the following:

"Corrosion protection of flexible couplings shall be in accordance with Particular Specification SPE-JJ-0003 and its amendments."

3.4.3 Joints, bolts, nuts and washers (Subclause 3.9.5)

Replace the contents of this Subclause with the following:

"All fasteners (i.e. nuts, bolts and washers, etc.) shall be of equal or better corrosion resistance than the items being fastened, and shall under no circumstance have corrosion resistant properties less than that provided by hot dip galvanising. For example, SS316 or better fasteners must be used to fasten together SS316 flanges, HDG or better fasteners must be used to fasten together HDG flanges. Plated fasteners will not be accepted.

Washers shall be fitted under both bolt head and nut.

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Bolts and nuts shall be treated with nickel anti-seize paste before assembly."

3.4.4 Corrosive soil (Subclause 3.9.6)

Replace the heading of this Subclause with the following:

"Buried pipework"

Replace the contents of this Subclause with the following:

"All buried steel, cast iron and ductile iron pipework flanges, joints and valves shall be wrapped in an approved petroleum-based paste and adhesive tape ("Denso tape" or equal approved) strictly in accordance with System 10 of Particular Specification SPE-JJ-0003 and the manufacturer's instructions.

All buried stainless steel and HDG pipework shall be wrapped in an approved petroleum-based paste and adhesive tape ("Denso tape" or equal approved) strictly in accordance with System 10 of Particular Specification SPE-JJ-0003 and the manufacturer's instructions."

3.5 VALVES (SUBCLAUSE 3.10)

Replace the contents of this Subclause with the following:

"Valves shall comply with the relevant Particular Specifications applicable to the different types of valves listed under C3.7.5 and the associated amendments under C3.7.6. Where no specifications are provided, valves shall comply with the requirements of SANS 1200 LK."

3.6 MANHOLES AND SURFACE BOXES (SUBCLAUSE 3.11)

3.6.1 Precast cylinders (Subclause 3.11.2)

Delete the reference to SABS 1294 and replace with "SANS 1294:2012".

Add the following:

"All precast sections shall be manufactured from dolomitic aggregate. Dolomitic aggregate and dolomitic sand shall be used for all concrete, mortar, benching and plaster used in manholes."

3.6.2 Step irons (Subclause 3.11.4)

Replace the contents of this Subclause with the following:

"Unless otherwise indicated on the drawings, step irons shall be manufactured of copolymer polypropylene with a 12 mm diameter high tensile steel core. The step irons shall be installed in accordance with the manufacturer's specifications."

3.6.3 Manhole covers and frames (Subclause 3.11.5)

Replace the contents of Subclause 3.11.5.1 with the following:

"Unless otherwise indicated on the drawings, all manhole covers shall be Type 2A in accordance with SANS 1882. All manhole covers shall be lockable with a stainless-steel locking mechanism. The locks shall have a universal key in accordance with the City of Cape Town requirements. At the end of the project, 5 x copies of the universal key shall be handed over to the Employer."

3.6.4 Surface Boxes (Subclause 3.11.6)

Replace the contents of this subclase with the following:

"Unless otherwise indicated on the drawings, all surface boxes shall be Type 3B in accordance with SANS 1882."

Add the following new subclauses:

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3.7 MARKING (NEW SUBCLAUSE 3.12)

All pipes, specials and valves arriving on site shall be marked clearly with the item number appearing in the Bill of Quantities. Furthermore, the nuts, bolts, washers and other ancillary equipment for each individual item shall be kept separate in a bag which shall also bear the respective reference number for that item. The cost of such marking will be held to have been included in the rates tendered for the items.

3.8 PROTECTION DURING STORAGE, HANDLING AND CONSTRUCTION (NEW SUBCLAUSE 3.13)

The Contractor shall satisfy the Employer's Agent that the manufacturers' recommendations for good practice for the transporting, handling, stacking, storing and installing of pipes, pipe fittings, sealing rubbers etc. are being diligently followed. The Employer's Agent's Representative shall be given the opportunity to inspect all materials immediately prior to installation and shall have the right to reject any materials which, in his opinion, have suffered damage which may impair the long term durability or strength of said items.

Pipes and specials shall be protected against damage during all stages of manufacture, delivery, storage and handling.

Until required, rubber rings and couplings in which there are rubber rings shall be stored undercover in a cool, dark place, away from grease, oil and harmful chemicals. If rubber rings are tied in bundles they shall be untied at least 2 days before being required to allow the rubber rings to recover from any tie marks and indentations.

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 LAYING (SUBCLAUSE 5.1)

5.1.1 General (Subclause 5.1.1)

Add the following to the end of this Subclause:

"The pipelines shall be laid to the invert levels and gradients shown on the drawings.

Horizontal and vertical angular deviations at flexible couplings shall be limited to the maximum angle specified by the pipe manufacturers.

The Contractor shall protect all buried pipe fittings, valves and joints including fasteners against corrosion by wrapping them in accordance with subclause 3.9.6.

Curving of HDPE pipes to a radius not exceeding 20 x outside diameter of the pipe, or as permitted by the pipe manufacturer, shall be permitted in lieu of bends.

"

5.1.2 Damage (Subclause 5.1.2)

Add the following to the end of this Subclause:

"The following shall apply with respect to surface damage to HDPE pipes:

a) All diameters: Any form of surface damage greater than 10% of the minimum wall thickness shall not be allowed.

b) All diameters: Any surface damage located closer than 200 mm from the pipe ends shall not be allowed.

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c) ≤ DN110: Surface damage shall not exceed 10% of the minimum wall thickness and shall not be greater than 75 mm in length. The distance between surface damages shall not be less than 300 mm and no more than two (2) defects shall be permitted per 6 metre length of pipe (reduced number of defects pro rata per length).

d) > DN110: Surface damage shall not exceed 5% of the minimum wall thickness and shall not be greater than 75 mm in length. The distance between surface damages shall not be less than 300 mm and no more than three (3) defects shall be permitted per 6 metre length of pipe (reduced number of defects pro rata per length).

Pipes not conforming to these criteria shall be rejected."

5.1.3 Depths and cover (Subclause 5.1.4)

Replace the contents of this Subclause with:

"The minimum clearances at crossings between the barrels of proposed pipelines or between existing and proposed pipelines shall be 300 mm. The pipeline shall be laid horizontally at this level for a distance of at least 1,0 m on either side of the centreline of the service crossed. The Contractor shall inform the Employer's Agent should he find that this minimum clearance cannot be achieved."

Add the following to the end of Subclause 5.1.4:

"5.1.4.6 The pipelines shall be laid to the invert levels and gradients shown on the drawings and so that the minimum cover to the top of the pipe barrel from finished surface level is 1.0 m unless otherwise specified."

5.1.4 Setting out (New Subclause 5.1.5)

The Contractor shall clearly mark the pipeline route for the approval of the Employer's Agent prior to commencing with and trench excavation. The requirements for marker posts shall apply.

5.1.5 Marker posts (New Subclause 5.1.6)

The Contractor shall supply and accurately place marker posts on the centreline of buried pipelines, or as instructed by the Employer's Agent. Marker posts shall be placed at all points of intersection, chambers and at a maximum spacing of 250 m. Marker posts shall be placed only once the pipelines, or any sections thereof, have been successfully tested and the trenches backfilled.

The manufacture, installation and identification marks of marker posts shall comply with the drawings. Where no drawing exists, the Contractor shall propose marker posts that are suitable for the purpose, for approval of the Employer's Agent.

The co-ordinates, level and centreline distance (as determined from the as-built survey and drawings) of each marker post shall be accurately determined and recorded by the Contractor. All details shall be given to the Employer's Agent in writing.

5.2 JOINTING METHODS (SUBCLAUSE 5.2)

5.2.1 Detachable Couplings (AC and uPVC Pipelines) (Subclause 5.2.1)

Add the following to the start of this Subclause:

"The requirements of W&S-BW-010 shall take precedence over this Subclause with regards to straight couplings, stepped couplings and flange adaptors."

5.2.2 Welding (Steel Pipelines of Diameter 600 mm or greater) (Subclause 5.2.3)

Omit the words "of Diameter 600 mm or greater" *from the Subclause heading.*

Delete the contents of this subclause and replace with the following:

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"All welded joints for steel pipes, fittings and specials shall be done in accordance with Particular Specification SPE-CC-7003 and its amendments."

5.2.3 HDPE Welding (New Subclause 5.2.5)

The HDPE pipes and specials shall be joined by means of butt fusion using approved, butt welding equipment and fully accredited, trained plastic welders in accordance with the manufacturer's code of practice. The Contractor shall undertake the following steps prior to the commencement of welding on site:

a) Provide a Welding Procedure Specification (WPS)

b) Provide welding tables applicable specifically to pipe diameters and pressure classes to be welded and the welding equipment used.

c) Provide a certificate of calibration for the welding machine to be used. The certificate shall bear the model number of the welding machine, the name and the address of the certifying agent, the date of the test and a statement as to the accuracy of the temperature and pressure gauges on the machine in question.

d) A certificate of calibration dated more than 12-months from the Commencement Date is not acceptable.

e) Provide certification that the welder/operator has successfully completed an approved training course in accordance with SANS 10269 and is qualified to weld the sizes and pressure classes of HDPE pipe to be used on this Contract. The certificate shall be issued within the previous 12 months from construction commencing on site.

f) A test weld, on each pipe diameter and pressure class, is to be undertaken on site in the presence of the Employer's Agent's Representative for approval prior to the commencement of welding the pipes. The test weld(s) shall also be submitted to an approved laboratory and be tested in accordance with SANS 6269. A minimum weld factor of 1.0 is required.

Under no circumstances will welding be permitted to commence prior to the provisions of the abovementioned certificates and the weld test, and the cost of delays resulting from failure to timeously undertake the abovementioned steps shall be borne by the Contractor.

Each joint is to be uniquely numbered and a record shall be kept detailing the date, pipe details, weather, welding conditions, initial bead height, welding times and final position of joint in the ground, a copy of which shall be forwarded to the Employer's Agent.

To remove any residual dust and other fine contaminants on the heater plate, a dummy joint shall be made at the start of each day or when changing between pipe sizes.

Unless otherwise approved, the external and/or internal beads shall be removed using suitable debeading tools. The beads and joint shall be numbered/coded using an indelible marker pen to correspond with the joint details entered into the butt fusion machine data retrieval system.

During construction, the Employer's Agents Representative shall order the cutting out of ad hoc joints for testing in accordance with SANS 6269 at an independent testing facility. A minimum of one joint per one hundred joints, with the same welding machine, shall be tested.

If it is necessary to cut pipes, the cut ends shall be turned using a field lathe. Filing of the coupling surfaces of pipes will not be permitted.

5.2.4 uPVC solvent welding (New Subclause 5.2.6)

Where solvent welding is specified for uPVC pipes and fittings, the welding process shall be in accordance with SANS 10268-5:2004. Solvent cements shall comply with SANS 1655."

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5.3 SETTING OF VALVES, SPECIALS, AND FITTINGS (SUBCLAUSE 5.3)

Replace the last paragraph of this Subclause with the following:

Valves requiring special adjustment after installation such as self-closing valves shall be commissioned by representatives of the valve manufacturers. Similarly, meters shall be commissioned by the respective suppliers after installation by the Contractor.

The mass of valves or water meters shall at no time be carried by the pipe, the flange or the coupling. Support stools shall be constructed as soon as practicable after the installation of valves and meters, and shall generally be constructed of steel, concrete or masonry work. Where fabricated steel stools are approved or specified, they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Employer's Agent's approval. Supports shall be welded to the pipe only where specified and linings of pipes and specials shall be made good after welding.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Employer's Agent in writing.

Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Employer's Agent may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted. Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate."

5.4 ANCHOR/THRUST BLOCKS AND PEDESTALS (SUBCLAUSE 5.5)

Add the following to the end of this Subclause:

"Thrust blocks are required for all bends where flexible joints are used. These thrust blocks are not necessarily required for pipelines that are continuously welded or where locked joints are used.

Where locked joints are used in lieu of thrust blocks, the Contractor shall submit to the Employer's Agent the relevant calculations of the anchored lengths for all relevant bends.

The concrete in the thrust blocks shall be at least Class 25 MPa/19 mm. The minimum cover to the steel shall be 50 mm. Where no reinforcement is shown, the Contractor shall allow 100 kg/m^3 of concrete in his rates."

5.5 VALVES AND HYDRANT CHAMBERS (SUBCLAUSE 5.6)

5.5.1 General (Subclause 5.6.1)

Replace the words "drawing L-1" *in the second line with* "the Drawings".

5.5.2 Construction of Chambers (Subclause 5.6.2)

Replace the words "drawing L-1, L-2 and L-3" *in the fourth line with* "the Drawings".

Add the following subclauses:

5.6 END CAPS (NEW SUBCLAUSE 5.11)

The Contractor shall, at the end of each day's work, fit end caps to the open ends of the pipeline under construction. The end caps shall be manufactured in such a manner that it can be fitted to seal off the pipeline

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to the extent that it is totally dust and water proof. The end cap must be able to withstand a pressure of 5 m head of water externally when fitted.

End caps shall be maintained during non-working periods.

5.7 FLEXIBLE CONNECTIONS AT STRUCTURES (NEW SUBCLAUSE 5.12)

In order to avoid damage to pipes due to differential movement where the pipes connect to chambers or other structures, all rigid pipes built and/or grouted into such structures shall be provided with flexible connections in accordance with SANS 1200 LD Drawing LD-2 (unless shown otherwise on the project-specific drawings).

Where PVC pipes connect to any structure a "Lyng" type PVC double socket (or where applicable, a bend) shall be fitted directly into the machined collar of the associated puddle pipe.

HDPE pipelines are considered flexible pipelines and shall connect via a restrained flanged special built into the structure.

5.8 CLEANING PIPE INTERNALS, VALVES AND FITTINGS (NEW SUBCLAUSE 5.13)

The Contractor shall ensure that all pipework is installed internally free of any contaminants. All traces of dirty water, cuttings, dirt and other debris are to be removed from the inside of the pipe as it is installed.

The Contractor shall take note that flushing of the completed pipelines may not be allowed after construction has been completed and therefore clean house keeping practices will be required under all circumstances during construction. The tendered rates for pipe laying shall include for the clean house keeping practices required.

Each section of the pipeline is to be internally inspected and passed by the Employer's Agent once construction has been completed. If the pipework is not satisfactory, the Contractor shall re-clean the pipe at his own expense until the pipe is passed clean. The Employer's Agent reserves the right to utilize cameras or any other means to inspect inaccessible areas.

All flanges, valves, fittings and equipment are to be installed in pipework only after they have been thoroughly cleaned. Flange faces shall be checked for damage before being incorporated into the permanent works and any damage shall be reported to the Employer's Agent.

5.9 PREVENTION OF FLOTATION OF PIPEWORK (NEW SUBCLAUSE 5.14)

The Contractor will take all necessary precautions to temporarily restrain pipework until it has been successfully tested and backfilled over to prevent the potential of flotation of the pipework by rising water tables in the soil. See also Subclause 5.5 of SANS 1200 A.

Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipework due to storm runoff or groundwater entering the trench before backfilling has been completed.

Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Employer's Agent. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

6 TOLERANCES (CLAUSE 6)

6.1 CONTROL POINTS (SUBCLAUSE 6.2)

Amend the permissible deviation of +- 4 m in the second last line of this Subclause with +- 2m.

6.2 ALIGNMENT (PLAN AND LEVEL) (SUBCLAUSE 6.3)

Amend the permissible deviation of +- 20 % in the third last line of this Subclause with +- 10 %.

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6.3

7 TESTING (CLAUSE 7)

7.1 GENERAL (SUBCLAUSE 7.1)

Add the following to the start of this Subclause:

"Pipelines designed for potable use shall be hydraulically tested and disinfected using potable water.

The Contractor shall submit to the Employer's Agent a detailed method statement describing the timing, methodology and scheduling of each hydrostatic pressure test to be undertaken. No test shall proceed before approval of such method statement by the Employer's Agent. Under no circumstances will the Contractor be allowed to carry out filling, testing and disinfecting of the pipeline without the supervision of the Employer's Agent, neither shall the Contractor permit any other persons to carry out such said activities without the written permission of the Employer's Agent."

Add the following to the end of this Subclause:

"Over and above other tests specified, all pipelines shall be hydraulically tested. The pipelines shall be fitted with all valves, fittings and couplings required to complete the section before testing will be permitted. The Contractor shall construct temporary thrust blocks and provide temporary plugs, blank flanges and other isolating devices where required for testing at no extra cost to the Employer.

Before any tests are carried out, the test pressures and test points shall be confirmed with the Employer's Agent. The Contractor shall provide all equipment required for the pressure testing of the pipeline."

7.2 INITIAL TESTS ON WELDED STEEL PIPES (SUBCLAUSE 7.2)

Delete the contents of this subclause and replace with the following: "Welded steel pipes shall be tested in accordance with Particular Specification SPE-CC-7003 and its relevant amendments."

7.3 STANDARD HYDRAULIC PIPE TEST (SUBCLAUSE 7.3)

7.3.1 Test pressure and time of test (Subclause 7.3.1)

Replace the last sentence of Subclause 7.3.1.1 with the following:

Where mixed types or classes of pipe occur, and where the pipeline traverses a wide range of altitudes, the pipeline shall be tested in reduced lengths necessary to comply with 7.3.1.2. Any temporary valves, blank flanges, thrust blocks or other isolating devices required shall be provided by the Contractor at no additional cost to the Employer.

Replace Subclause 7.3.1.2, 7.3.1.3 & 7.3.1.4 with the following:

"The field test pressure applied over any section of pipeline under test, taking differences in elevation along the pipeline into account, shall not be less than the maximum design pressure or exceed 1.25 times the maximum design pressure, unless otherwise specified in the Project Specification, on the drawings or by the Employer's Agent."

7.3.2 Permissible leakage rates (Subclause 7.3.3)

Add the following pipe materials to those listed in item b):

"HPDE, PVC-M, PVC-O"

Add the following new subclauses:

7.3.3 Initial filling of pipeline (New Subclause 7.3.4)

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Unless otherwise specified or approved in writing by the Employer's Agent, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s. Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

Water used for one filling of the pipeline for hydraulic testing, and in the case of potable pipelines, one filling for disinfection and one filling after draining, will be provided by the Employer to the Contractor, free of charge, at connection points stated in the Project Specification or instructed by the Employer's Agent. Additional water supplied by the Employer owing to unsuccessful hydraulic testing and/or disinfection will be charged to the Contractor.

7.3.4 Disinfection of pipeline (New Subclause 7.3.5)

Pipelines designated for potable use shall be disinfected after the hydraulic testing has been successfully completed and approved by the Employer's Agent. Water used for the hydraulic testing shall be drained and the pipeline filled, subject to 7.3.4, using potable water with a 1.0 mg/L chlorine solution until completely full. Once completely full, the pipeline shall be allowed to stand a minimum of 3 hours for disinfection unless otherwise instructed by the Employer's Agent and then drained completely. All valves and pipe ends shall be closed, and no drainage or leakage is permitted during the time for disinfection.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Supply, lay and bed pipes complete with couplings (Subclause 8.2.1)

Delete "(See 8.2.4)" from the end of this Subclause.

Add the following to the end of this Subclause:

"The rates for supplying, laying and bedding pipes shall cover the cost of testing.

The rates shall also cover the cost of any cutting and jointing (including nuts, bolts, washers, gaskets, etc.) required for temporary or permanent closure of pipes or for the creation of flexible connections at structures. The rate shall include working in restricted working widths as indicated on the drawings or specifications.

The rates shall further cover the cost of marking of the items, complying with marker posts requirements, corrosion protection as specified, wrapping of flanges and couplings with "denso" tape or similar approved, supply and fitment of temporary end caps, cleaning the pipes, and all specified testing (including all cost associated with completing the tests including temporary thrust blocks, temporary isolating devices, etc.).

"

8.1.2 Extra-over 8.2.1 for the supplying, laying and bedding of specials complete with couplings (Subclause 8.2.2)

Add the following at the end of this Subclause:

"The contents of 8.2.3 shall apply."

8.1.3 Extra-over 8.2.1 for the supplying, fixing and bedding of valves (Subclause 8.2.3)

*Add "*complete with couplings*" to the end of the heading for this Subclause.*

Replace the contents of this Subclause with the following:

Specials and valves will be measured by the number of each type, class, and size.

The rates, which shall be extra-over the rates for 8.2.1, shall cover the cost of the design and provision of each special or valve, complete with specified couplings, supports, all nuts, bolts, gaskets, etc. and the cost of marking of the items, handling, inspecting, transporting, fixing, bedding, and testing of the special or valve, as applicable, and the cutting of the pipes and preparation of pipe ends.

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The rates shall also cover the cost of machined collars on the specials (where shown on drawings) and the couplings/welds necessary to fit the special and valves to the associated pipeline. The rates shall further cover the cost of corrosion protection as specified, the repair of corrosion protection (as applicable), and the wrapping of flanges and couplings with "denso" tape or similar approved.

No extra payment over and above the rates will be made in respect of any additional cutting, turning, and jointing of pipes required for the location of valves, specials, etc., in the positions given on the drawings.

No extra over payment will be made for bends smaller than 5° for pipes with flexible joints. The cost for bends or angular deviations at flexible couplings shall be deemed to be included in the tendered rate for 8.2.1

Unless specific provision is made in the schedule, no separate payment will be made for the supply and fitting of any additional joints and jointing materials which may be required for the connection of shortened pipe lengths.

8.1.4 Extra-over 8.2.1 for encasing joints (Subclause 8.2.7)

Delete this Subclause and its heading.

The cost of encasing joints shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3, where the cost of the specified corrosion protection and wrapping of flanges and couplings with "denso" tape (or similar approved) is included.

8.1.5 Temporary Valves, etc. (Subclause 8.2.10)

Delete this Subclause and its heading.

Payment for temporary valves, end caps, blank flanges, or other isolating devices required to complete installation and testing requirements shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3,

8.1.6 Anchor/Thrust blocks and pedestals (Subclause 8.2.11)

Add the following to the end of the 2nd last paragraph of this Subclause:

"The rates given in b) above shall also include the cost of any excavation, trimming and backfill required.

In the final line of this Subclause, replace the words "and screeding of top surfaces." *with the following:*

"concrete, screeding of top surfaces and any backfill required. Where reinforcement is not indicated on the drawings, an amount of 100 kg of high tensile steel per cubic metre of concrete shall be included for.

Temporary thrust blocks will not be paid for."

8.1.7 Valve and hydrant chambers, etc. (Subclause 8.2.13)

*Replace the words "*complete units.*" in the first sentence with the following:*

"complete units, with depth increments as scheduled (if applicable). For the purpose of measurement and payment, the depth of a chamber is defined as the depth from the top of the cover to the invert level of the chamber (where the invert level for larger chambers is that of the main floor area and not the invert of a localized recess used for draining the chamber). For bell toby valve chambers, the crown of the pipe shall be taken as the chamber invert level."

Replace the last paragraph of this Subclause with:

"The rate shall cover the cost of any additional excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required). The rate shall further cover the cost of building the chambers, complete as shown on the relevant drawings, including castings, step irons, cover and frames (Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, etc., and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all necessary materials, plant and labour."

8.1.8 a) Manholes, b) Extra-over for manholes of depth exceeding 1,5 m (Subclause 8.2.14)

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[redacted]

At the end of the first paragraph of Subclause 8.2.14(a), replace the words "of overall depth not exceeding 1,5 m." *with the following:*

"of the incremental depths scheduled."

Add the following to the end of Subclause 8.2.14(a):

"For the purpose of measurement and payment, the depth of a manhole, inspection chamber, etc, is defined as the depth from the top of the cover to the invert level of the manhole, inspection chamber, etc.

The rate shall cover the cost of any additional excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required). The rate shall further cover the cost of building the manholes, complete as shown on the relevant drawings, including castings, step irons, cover and frames (Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, etc., and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all necessary materials, plant and labour."

Delete the heading and contents of Subclause 8.2.14(b).

8.1.9 Special Wrapping in Corrosive Soil (Subclause 8.2.15)

Delete this Subclause and it's heading.

The cost of wrapping shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3, where the cost of the specified corrosion protection and wrapping of flanges and couplings with "denso" tape (or similar approved) is included.

Add the following new subclauses:

8.1.10 Cutting into Existing Pipelines (New Subclause 8.2.16) Unit: No.

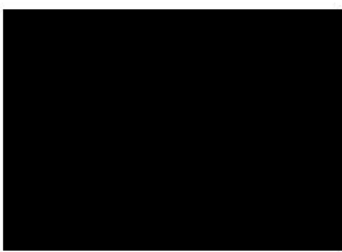
The tendered rate shall include full compensation for the cost of excavation, cutting into and connecting to a pipe of size and material as specified, removal of surplus material, all labour and equipment necessary to make the connection, making good and all liaison with the local authorities.

The cost of new pipe specials and couplings (where required) will be measured separately.

8.1.11 Miscellaneous (New Subclause 8.2.17)

The tendered sums or rates shall cover all costs required to execute and complete the work as specified and scheduled. This shall, for example, include full compensation for the supply of all materials, delivery to site, storage, all equipment and plant, labour, preparation, application, installation, testing, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion. Where this requires tying into an existing service, the rate shall further include managing the shutting-off/disconnection and turning-on/reconnection activities required to complete the work.

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1 SCOPE (CLAUSE 1)

Replace the contents of this Clause with the following:

"This specification covers the supply and installation of bedding (bedding cradle and selected fill blanket) for buried pipes carrying fluids under pressure or gravity.

Project-specific drawings (see definition) have been prepared to show the bedding details for various pipe types and installation conditions. As these project-specific drawings take precedence over the drawings which are included within the Standardised Specifications, these Standardised Specifications should be read in conjunction with the project-specific drawings.

NOTE: The standards referred to in the specification are listed in Appendix A."

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (SUBCLAUSE 2.3)

In the definition for "Main fill" *delete* "150 mm" *in second line and substitute* "300 mm".

Add the following at the start of the definition for "Flexible pipe":
"A pipe made of Steel, GRP, uPVC or HDPE, or otherwise "

Add the following at the start of the definition for "Rigid pipe":
"A pipe made of concrete, or otherwise "

Add the following new definitions:
"Stiffness ratio. Modulus of soil reaction, also known as the constrained soil modulus, of the bedding material."
"Project-specific drawings. Drawings other than those included within the Standardised Specifications. For example, drawings LB-1 and LB-2, etc. are not project-specific drawings."

3 MATERIALS (CLAUSE 3)

3.1 SELECTED GRANULAR MATERIAL (SUBCLAUSE 3.1)

Add to the following to this Subclause:

"Unless otherwise specified, the selected granular material shall consist of sand and the maximum particle size shall be restricted to 5mm as detailed in Subclause 3.3 below."

3.2 SELECTED FILL MATERIAL (SUBCLAUSE 3.2)

Replace the contents of this Subclause with the following:

"The material for selected fill shall be selected granular as per Subclause 3.1 (and measured as such), unless indicated otherwise on the project-specific drawings."

3.3 BEDDING (SUBCLAUSE 3.3)

In the first line, replace "Class A, B, C or D" *with* "Class B".

Add the following to this Subclause:

"Bedding (selected granular and selected fill material) for flexible pipes shall be fine sand or fine non-cohesive soil, carefully selected, with maximum particle size of 5 mm and which shall not cake nor form lumps when drying. Samples of bedding sand shall be submitted by the Contractor to the Employer's Agent for approval well in advance of construction. Only after the Contractor has received written approval from the Employer's Agent, may he/she proceed with placing sand as selected granular material.

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No sharp-edged stones shall be allowed to come into contact with the flexible pipes or associated fittings. Joint holes (pockets) shall be provided in the trench bottom and bedding, at each pipe joint to facilitate inspection or welding where applicable, and no extra payment will be made for forming or filling the joint holes (pockets) with bedding sand.

The material shall be free of organic matter and shall have a compactibility factor of not more than 0,4. The material should be classified as silty to fine sand having a stiffness ratio of not less than 6,0 MPa. The origin of the materials should, preferably, be river transported since it is preferable that the larger grains be rounded and not sharp and angular.

The Contractor will be required to carry out his/her own quality control testing of the material to ensure that it meets the bedding sand requirements and complies with this specification at all times.

Depending on the actual material supplied by the Contractor, the moisture content may be critical to enable satisfactory placing and compaction and the Contractor will be deemed to have allowed in his tendered rate for any and all adjustments required to the moisture content of the bedding material at all times.

Items have been provided in the Bill of Quantities for the provision of approved bedding sand from approved Commercial or other approved off-site sources for bedding sand.

No extra payment will be made for forming or filling joint holes (pockets)."

3.4 SELECTION (SUBCLAUSE 3.4)

3.4.1 Suitable material available from trench excavation (Subclause 3.4.1)

Replace the words "(but is not required)" *in the fourth and fifth lines with the words* "(at his own cost)".

Add the following to this Subclause:

"If, in the opinion of the Employer's Agent, bedding material can be produced from the excavated material, the Contractor shall, if so ordered by the Employer's Agent, screen or otherwise treat (as scheduled) the excavated material in order to produce material suitable for bedding (see also Subclause 8.2.1 below)."

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 GENERAL (SUBCLAUSE 5.1)

5.1.1 Details of bedding (Subclause 5.1.2)

Replace the words "Pipes shall be bedded and protected in accordance with" *with the following:*

"Pipes shall be bedded and protected in accordance with the details shown on the project-specific drawings. Where no project-specific drawings are provided or where they do not cover certain pipe sizes or types, the pipes shall be bedded and protected in accordance with"

5.1.1.1 Stone draining layer beneath bedding (New Subclause 5.1.2.1)

"Where indicated on the drawings, or as otherwise instructed by the Employer's Agent, a 200 mm thick layer of 19 mm stone shall be placed beneath the bedding layer to act as a drainage channel for excessive groundwater. This stone layer shall be wrapped in geofabric and provided with outlet pipes if and where indicated."

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5.1.2 Compacting (Subclause 5.1.4)

Replace the contents of this subclause with the following:

"Unless indicated otherwise on the project-specific drawings, the degree of compaction attained for bedding (other than concrete and the main fill material over the top of the pipeline) shall be 93 % of modified AASHTO maximum density (see 6.1).

Steps will have to be taken by the Contractor to ensure that flexible pipes do not deform excessively in cross-section during and after construction and backfilling operations. The maximum deflection which will be acceptable at any stage during or after construction shall be the minimum of 2% of the pipe diameter horizontally or vertically, or the maximum deflection permitted by the pipe manufacturer that will prevent damage to the coating and lining. The Contractor will be required to provide the necessary apparatus and to monitor deflection during construction.

Pipe deformations will only be maintained within the specified tolerances by correct backfilling practice. No heavy compaction equipment will be permitted for compaction of any pipe bedding, only pneumatic or hand rammers being acceptable. To this end, and to achieve the 93% (100% for sand) compaction specified it is required that the bedding material be brought up evenly on either side of the pipe. The use of complete saturation of the material as a method of achieving the specified compaction may, subject to the Employer's Agent's approval, be used. However, in this regard, the Contractor is advised that the presence of excessive quantities of water in the pipe trench could lead to flotation of the pipe.

Prior to the commencement of pipe laying the Contractor will be required to submit, to the Employer's Agent, for his approval, his proposed methods of placing, and compacting methods which he proposes to implement in order to ensure compliance with the specification."

5.1.3 Testing (New Subclause 5.1.5)

All pipe joints and pipe fittings shall be left exposed with a minimum of 300 mm clearance around the bottom of the pipe during hydraulic pressure testing of the pipe to facilitate inspection.

5.2 PLACING AND COMPACTING FLEXIBLE PIPES (SUBCLAUSE 5.3)

5.2.1 Bedding cradle (Subclause 5.3.a)

Delete the contents of this Subclause and substitute with the following:

"Unless indicated otherwise on the project-specific drawings, the pipes shall be bedded on a minimum 100 mm thick layer of compacted granular bedding material on which a 50 mm thick layer of uncompacted granular bedding material has been placed and spread. Loose granular bedding material lying next to the pipe shall be placed into the haunch area and compacted with suitable hand tools (covered with rubber to prevent damage to the pipe coating), and additional selected granular material shall be added and compacted in layers up to the mid-point of the pipe diameter in the vertical plane. The remainder of the bedding i.e. the selected fill blanket, shall be placed in layers up the sides of the pipe, each layer being compacted until a level of 300 mm above the crown of the pipe is reached.

All joint (fox) holes shall be filled with bedding material."

5.2.2 200 mm Selected fill blanket (Subclause 5.3.b)

Delete "200 mm" from title.

5.3 CONCRETE CASING TO PIPES (SUBCLAUSE 5.4)

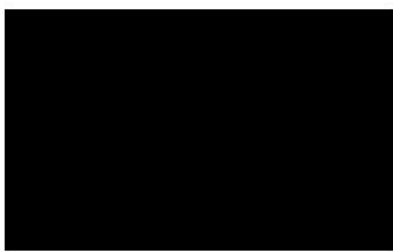
Replace the contents of this Subclause with the following:

"The requirements under this Subclause shall only be used where the encasing of pipes in concrete is scheduled under 8.2.4 Encasing of Pipes in Concrete.

Where the Employer's Agent requires pipes to be encased in concrete, a class 25 MPa/19 mm for unreinforced, 30 MPa/19 mm for reinforced or such other class as is scheduled, shall be used. The work shall be done as follows:

a) Concrete casing shall be discontinuous at flexible couplings in the pipeline.

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b) The pipe trench for the concrete encased pipeline shall be excavated to the depth below the bottom surface of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade.

c) The in situ concrete bed 150 mm thick shall be cast and the pipeline laid thereon true to line and level leaving a gap nowhere less than 50 mm between the pipe and the bed. If the encasement on the drawings is shown to extend further than 200mm below the invert of the pipe, the 150mm thick concrete bed shall be increased accordingly.

d) After jointing, the pipes shall be secured to steel loops left in/anchored to the bed. Concrete shall then be punned under and around the pipes from one side only until the bottom quarter of circumference of the pipes is in contact with the concrete bed.

e) The pipe shall be hydraulically tested in accordance with the applicable specifications, care being taken to ensure that the pipe does not move during testing.

f) After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position up both sides of the pipe. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings.

g) No casting of subsequent concrete members or earth filling over the concrete encasing shall be commenced until the concrete encasing has achieved its 28-day compressive strength (minimum 7 days)."

6 TOLERANCES (CLAUSE 6)

6.1 MOISTURE CONTENT AND DENSITY (SUBCLAUSE 6.1)

In this Subclause, replace "be as given below, appropriate to the particular class of work" *in the first sentence with* "be those for Degree of Accuracy II class of work, as given below"

7 TESTING (CLAUSE 7)

7.1 DENSITY (SUBCLAUSE 7.1)

Replace the contents of this subclause with the following:

"The Contractor shall carry out density tests as specified in TMH1: Standard Methods of Testing Road Construction Materials, 1986, in the positions indicated by the Employer's Agent, to determine the compaction of the bedding material.

At least two density tests per 20 m of installed pipe, one on each side of the pipe, per layer backfilled, shall be done. The Contractor shall bear the cost of these density tests. The Contractor shall also bear the cost of additional density tests ordered by the Employer's Agent where the test results of these additional tests are below the specified density.

No single test result which is below the specified density, will be accepted. If the density is found, in any case, to be below the specified value, the Employer's Agent may order the re-compaction of the bedding and retesting, both at the Contractor's expense."

Add the following new subclause:

7.2 GRADING (NEW SUBCLAUSE 7.3)

At least one grading analysis shall be carried out for every 500 lineal metres of bedding placed. The results of these tests shall be forwarded to the Employer's Agent within 24 hours of completion of the test. Should

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the material not comply with the specification, the Contractor shall remove and replace it with approved material at his/her own cost.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 PRINCIPLES (SUBCLAUSE 8.1)

8.1.1 Volume of bedding materials (Subclause 8.1.3)

Add to this Subclause:

"(c) The volume of bedding material shall be measured net i.e. the volume of the pipe is to be deducted.

(d) No additional payment will be made for bedding material placed in joint (fox) holes.

(e) The rate for bedding and backfill material from insitu material shall include the selection of the material."

8.1.2 Disposal of displaced material (Subclause 8.1.5)

Replace the contents of this subclause with the following:

"Material displaced by the pipeline and by imported material from sources other than trench excavation, shall be disposed of at an approved site furnished by the Contractor. No haulage is payable for such material."

8.1.3 Freehaul (Subclause 8.1.6)

Delete the contents of this Subclause and substitute the following:

"Subclause 5.2.5 of SANS 1200D and its amendments shall be applicable."

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.2.1 Provision of bedding from trench excavation (Subclause 8.2.1)

Delete the contents of this Subclause and substitute the following:

"a) Selected granular material ..... Unit : m^3

i) Without the need for screening:

The rates shall cover the cost of acquiring, from any point along the trench excavation as may be selected by the Employer's Agent, bedding that complies with the relevant requirements of the specification, of delivering it to points alongside the trench spaced to suit the Contractor's methods of working, of making good any backfill deficiency from points where backfill has been acquired, and of disposing of displaced material.

ii) Including for screening:

The rates shall cover the cost of screening or otherwise treating excavated material, at any point along the trench excavation as may be selected by the Employer's Agent, in order to produce bedding that complies with the relevant specification, delivering it to points alongside the trench, spaced to suit the Contractor's methods of working, of making good any backfill deficiency there may be from points where screened backfill material has been acquired, and of disposing of displaced material."

8.2.2 Supply only of bedding by importation (Subclause 8.2.2)

Delete Subclause 8.2.2.1 and substitute the following:

"8.2.2.1 From other necessary excavations including for screening and/or other treatment:

a) Selected granular material ..... Unit : m^3

b) Bedding sand to specified bedding dimensions ..... Unit : m^3

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The rates shall cover the cost of acquiring, loading, transporting, offloading, screening or otherwise treating excavated material in order to produce bedding that complies with the relevant specification, delivering it to points alongside the trench spaced to suit the Contractor's methods of working and of disposing of displaced material.

NOTE: The rate for the supply and laying of pipelines covers the cost of handling the bedding material from alongside the trench, placing it under the pipeline, forming joint holes and completing the bedding around and over the pipeline."

Delete the words "of 0.5 km" *in the last line of Subclause 8.2.2.3.*

8.2.3 Concrete bedding cradle (Subclause 8.2.3)

Add the following paragraph to the Subclause:

"All concrete bedding to pipes will require formwork. The rate for concrete bedding shall include for the supply, installation and stripping of all formwork."

8.2.4 Encasing of pipes in concrete (Subclause 8.2.4)

Replace the first sentence with the following:

Separate items will be scheduled for each size of pipe (or range of pipes), for each grade of concrete specified and whether the encasing is unreinforced or reinforced (unreinforced unless otherwise specified).

Delete the fifth and sixth lines and substitute the following:

"encasing the pipe in concrete including the cost of formwork (if any, inclusive of supply, installation and stripping, etc.), the cost of formwork to form stop ends on either side of collars, couplings, joints, strapping and all other requirements as per Clause 5.4.

Where encasings are specified as reinforced, the rate shall also include the cost of reinforcing (120kg of steel reinforcing per m^3 of concrete encasing, unless otherwise specified). Where no encasing width or height is given on the drawings, the encasement shall extend 300 mm above and below the pipe and 300 mm on both sides of the pipe."

Add the following new subclauses:

8.2.5 Extra-over for bedding stabilised with 5% cement (New Subclause 8.2.6) ..... Unit : m^3

The tendered rate shall include full compensation for selecting, mixing, backfilling and compacting the stabilised material to 93% modified AASHTO density.

8.2.6 Provision of stone/geofabric bedding to deal with water (New Subclause 8.2.7) .... Unit : m^3/m^2

The provisions of Subclause 8.3.10 of SANS 1200 DB apply.

"

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

Add the following after "e) SANS 1200 DB":
"f) SANS 1200 GA"

3 MATERIALS (CLAUSE 3)

3.1 DUCTS (SUBCLAUSE 3.1)

Delete the following words at the start of this Subclause:

"Except that the GPO will supply all pipes for cable ducts required for GPO purposes,"

Add the following after item d):

"e) Kabelflex or similar approved in the case of HDPE pipes, complying with SANS 61386-24 (Type N 450)."

Add the following to the end of this Subclause:

"Ducts shall be supplied by the Contractor complete with end caps, joints, sealing and draw wires.

Unless otherwise specified on the drawings or in the Bill of Quantities, cable ducts shall be Kabelflex or similar approved HDPE ducts."

3.2 BEDDING (SUBCLAUSE 3.2)

Delete sub-clauses 3.2.1 and 3.2.2 and replace with the following:

"The requirements and specifications of subclause 3.1 of SANS 1200LB shall apply."

3.3 BACKFILL (SUBCLAUSE 3.3)

Notwithstanding the provisions of this subclause, the material to be used for backfilling in areas subject to road traffic loads shall be subbase quality material complying with the requirements of subclause 3.2.1 of SANS 1200 ME.

3.4 CABLE DUCT MARKERS (SUBCLAUSE 3.4)

Add the following to the end of this Subclause:

"A cable duct marker shall consist of a 300 mm x 300 mm x 100 mm deep, class 20 MPa/19 mm concrete block, connected by means of a non-ferrous metal strip to a temporary plug to seal the end of the duct. The plug shall prevent moisture or soil from entering the duct. The metal strip shall be firmly connected to both the plug and the concrete block. The concrete block shall be positioned not further than 0,5 m horizontally from the end of the cable duct. The face of the concrete block shall be clearly marked "E" to indicate electricity cables.

Temporary markers shall be provided at each duct end. The ends of all ducting pipes shall be temporarily

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marked with a 300x100x75 clay brick planted 200mm vertically into the ground directly above the end plugs. The ends of the draw ropes shall be attached to this brick marker. The exposed part of the brick marker shall be painted as follows:

- Electricity Red
- Telkom Green
- Communication Yellow

Permanent markers shall be provided in accordance with the requirements of subclause 5.10 in accordance to SANS 1200LC."

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 EXCAVATION OF TRENCHES (SUBCLAUSE 5.1)

Notwithstanding the contents of this subclause, the requirements of SANS 1200 DB shall apply.

5.2 Excavation for Trenches at Road Crossings (Subclause 5.1.3)

The requirements of subclause 5.4 in accordance of SANS 1200 DB shall apply with the additional proviso that the minimum depth of cover over ducts shall be 300mm where construction traffic is liable to cross them. Road crossings shall therefore be constructed after the construction of the roadworks has reached the stage where the required cover is available.

5.3 BEDDING AND COMPACTION OF BEDDING (SUBCLAUSE 5.2)

Notwithstanding the contents of this subclause, the requirements ofSANS 1200 LB shall apply.

5.4 DUCT LAYING (SUBCLAUSE 5.3)

5.5 Draw Wire (Subclause 5.3.3)

Notwithstanding the requirements of this Subclause, the nominal diameter of draw wire shall be 3mm.

Add the following new Clauses:

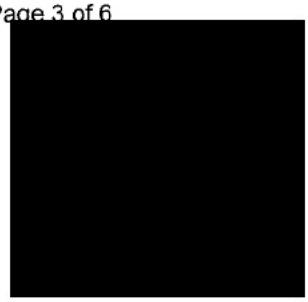
5.6 Laying to Grade (New Subclause 5.3.5)

Where two or more Telkom ducts of internal diameter greater than 75mm are laid together in the same trench, the ducts shall be laid to a minimum grade of 1:400.

5.7 Sealing of ends (New Subclause 5.3.6)

The ends of electrical ducts shall be sealed with end caps or suitable ingress and moist protection.

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5.8 LAYING OF TELECOMMUNICATIONS AND DATA DUCTS WITH OTHER SERVICES (SUBCLAUSE 5.6)

The horizontal separation between telecommunications ducts and other services shall be the maximum possible but in the case of electricity cables at least 300mm. Where the latter cannot be attained the ducts shall be separated from the cables by means of concrete protection slabs (see below) placed vertically.

No service other than telecommunications ducts shall be laid directly above and parallel to a telecommunication duct.

The concrete protection slabs mentioned above shall be 400mm square by 50mm thick and shall be reinforced with welded mesh ref. 193. The concrete used shall be 20MPa/13mm and the slabs shall be finished off to the satisfaction of the Employer's Agent.

Replace the heading and contents of Subclause 5.7 with the following:

5.9 CROSSING OF TELECOMMUNICATIONS WITH OTHER SERVICES (SUBCLAUSE 5.7)

Telecommunications ducts should preferably cross above other services. The radial separation at such crossings shall be the maximum possible but in the case of electricity cables at least 300mm. Where the latter cannot be attained, concrete protection slabs as specified in subclause 5.6 shall be placed above the electricity cable for a distance of 800mm on either side of the crossing (or below as the case may be).

5.10 ROAD CROSSINGS (SUBCLAUSE 5.8)

Delete the last sentence and replace with:

"The duct(s) shall extend a distance of at least 1m beyond the rear of kerb or walkway as applicable."

Add the following to subclause 5.8:

"Duct ends must be blanked off with endcaps, and all ducts laid are to be provided with galvanized draw-wires for subsequent cable-pulling operations by others."

5.11 POSITION TO BE MARKED (SUBCLAUSE 5.10)

Marking is required on both sides of the carriageway.

Delete in the second line: "...the letters "GPO or ESC", *as applicable, ...*" *and replace with* "...the letters "T" and "E", *as applicable.*"

Add: "The height of the letter shall be at least 100 mm."

6 TOLERANCES (CLAUSE 6)

No amendments.

7 TESTING (CLAUSE 7)

No amendments.

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8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 Excavation (Subclause 8.2.2)

In Subclause 8.2.2(b), replace both "1) Intermediate excavation" *and the corresponding unit of measure with* "1) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

And add the following to subclause 8.2.2(b):

"(i) Hard rock excavation Unit : m^3

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, which was excavated by hand on the specific prior written instructions of the Employer's Agent; provided always that the Employer's Agent said instruction shall have stated that measurement and payment for such hand excavation will be in accordance with this item.

The tendered rate shall include full compensation for the additional cost, effort and time resulting from excavating in the respective materials using hand methods only.

The Employer's Agent shall not be obliged to authorise payment under this item in respect of any hand excavation carried out (whether ordered in writing or otherwise), which hand excavation was in any case necessary to achieve compliance by the Contractor of his obligations under the Contract to:

1) utilise construction appropriate to the nature of the specific parts of the Works and/or
2) protect existing structures and/or services; and/or
3) comply with all prevailing legislation and regulations.

(ii) Hand excavation and backfill where directed by the Employer's Agent Unit : m^3

The rates shall cover the cost of excavating by means of hand tools within authorised dimensions, for all precautionary measures necessary to protect the services from damage during excavation and backfilling and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 93% of modified AASHTO density.

The rate for hand excavation in roadways shall also include compensation for compacting excavated or selected backfill material to 100% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for under SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water and for removal of surplus excavated material from the site."

(iii) Soilcrete backfill where directed by the Employer's Agent Unit : m^3

The unit of measurement shall be the cubic metre of soilcrete placed on the Employer's Agents instructions in accordance with Subclause 3.5(d) of SANS 1200 DB, measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required.

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8.2 Supply, lay, bed, and prove duct (Subclause 8.2.5)

Replace the contents of this Subclause with the following:

"Separate items will be scheduled for each diameter of duct.

The per meter rate shall be per meter of cable duct and not per meter of trench (i.e. for a 10m long trench with 4 ducts, it shall be 40m) and the rate shall cover the cost of providing the ducts (complete as specified in 3.1) and the cost of laying, jointing, bedding, building into draw pits, proving, and installing draw wire as specified. The rates shall also include for all costs involved in sealing and marking duct ends and the re-excavation and backfilling for marking purposes."

Replace the heading and contents of Subclause 8.2.6 with the following:

8.3 Provision of selected granular material complying with subclause C3.2 (Subclause 8.2.6)

8.3.1 From commercial or off-site sources located by the contractor ..... Unit: m³

The rate tendered for shall cover the cost or acquiring, regardless of distance, the required bedding from commercial or off-site sources located by the Contractor, delivering it to points alongside the trench spaced to suit the Contractor's method of working and disposing of material displaced by each operation at an approved site furnished by the Contractor. No haulage shall be payable for such material."

Add the following new subclauses:

8.4 Break in existing duct manhole and connect new duct up to 160mm dia. and make good (New Subclause 8.2.10) ..... Unit: No

"The tendered rate shall include full compensation for excavation, making an opening in the existing manhole, installing new duct in the new opening, for breaking out, ensuring the watertightness of the new connection, supplying all the necessary materials, removing surplus material and debris, all labour and equipment required to make the connection, and liaison with the local authorities."

8.5 Joining new duct to existing duct (New Subclause 8.2.11) ..... Unit: No

"The rate shall cover all costs for joining the two ducts, including the supply of any necessary couplings."

8.6 Imported backfill (source and quality stated) (New Subclause 8.2.12) ..... Unit: m³

"The provisions of Clause 8.3.3.1 of SANS 1200 DB shall apply, except that the trench width shall be determined in accordance with subclause 5.1.1 or that called for in terms of subclause 5.6."

8.7 Compaction in road crossing (95% of modified AASHTO maximum density) (New Subclause 8.2.13) ..... Unit: m³

"The provisions of item 8.3.3.3 shall apply, except that the trench width shall be determined in accordance with subclause 5.1.1 or that ordered in terms of subclause 5.6, and payment will be extra over that covered by item 8.2.2(a)."

8.8 Supply and installation of concrete protection slabs (New Subclause 8.2.14) ..... Unit: No

"The rate tendered shall cover the cost of all labour, plant and material required to manufacture the protection slabs as specified in subclause5.6, as well as placing and bedding the slabs."

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1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATION (CLAUSE 2)

2.1 ADDITIONAL ABBREVIATIONS (SUBCLAUSE 2.4)

Add to "AC: asbestos cement" *the following:*

"Now referred to as FC"

3 MATERIALS (CLAUSE 3)

3.1 PIPES, FITTINGS AND PIPE JOINTS (SUBCLAUSE 3.1)

Replace the heading and contents of Subclause 3.1.5 with the following:

3.1.1 uPVC Pipes (Subclause 3.1.5.1)

uPVC solid wall pipes shall comply with SANSS 791 with a pipe stiffness of 300 kPA (class 34 heavy duty), complete with integral sockets, joints, and rubber seal rings.

3.1.2 Fittings (Subclause 3.1.5.2)

Fittings for structured wall pipes shall comply with the requirements of SANS 791."

3.2 MANHOLES, CHAMBERS, ETC (SUBCLAUSE 3.5)

3.2.1 Bricks (Subclause 3.5.1)

Add the following:

""The requirements and specifications of subclause 5.6 of SANS 1200GA shall apply."

3.2.2 Precast concrete sections (Subclause 3.5.2)

Add the following:

"Sectional spun-concrete cylinders shall be manufactured from dolomitic aggregate."

3.2.3 Step irons (Subclause 3.5.7)

Delete the contents of this Subclause and substitute with the following:

"Step irons shall be of the copolymer polypropylene type with a 12 mm dia. high tensile steel reinforced core and shall be of length suitable for fixing in brick, precast concrete or reinforced fibre cement as applicable."

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3.2.4 Manholes covers and frames (Subclause 3.5.8)

Replace the contents of this Subclause with the following:

3.2.4.1 Precast concrete elements (Subclause 3.5.8.1)

Precast concrete roof slabs and covers shall comply with the applicable requirements of SANS 1294 and the strength requirements specified on the drawings. The elements shall be manufactured in accordance with the details shown on the drawings using concrete consisting of dolomitic aggregate.

Precast concrete roof slabs and covers shall be used throughout the works except in roadways, or where otherwise ordered by the Employer's Agent.

3.3 MARKER POSTS (SUBCLAUSE 3.6)

Replace the words "Project Specification" with "Drawings".

To the end of this Subclause, add the following:

"Where no drawings exist, the Contractor shall propose marker posts that are suitable for the purpose, for approval of the Employers Agent."

4 PLANT (CLAUSE 4)

No Amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 LAYING AND BEDDING (SUBCLAUSE 5.2)

5.1.1 Alignment (Subclause 5.2.2)

Add after "SANS 1200 LB" in the first sentence, the following:

"and the details shown on the drawings."

Replace the last sentence with the following:

"Pipes that have any deviation from straightness shall be so laid that preference is given to level over line."

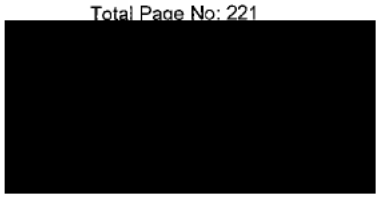
5.1.2 Jointing (New Subclause 5.2.6)

Jointing shall be carried out strictly in accordance with the manufacturer's instructions.

5.1.3 Depth of cover beneath roadways and vehicular trafficked areas during construction (New Subclause 5.2.7)

"The minimum depth of cover during construction shall be 750mm."

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5.2 MANHOLES, INSPECTION CHAMBERS, ETC. (SUBCLAUSE 5.6)

5.2.1 Benching (Subclause 5.6.2.1)

Notwithstanding the requirements of this subclause, pipes shall be prepared and built into manholes as shown on the drawings.

Replace "1:3 cement mortor" *in the first line of subclause 5.6.2.3 with the following:*

"concrete topping consisting of 1 part cement, 2 parts sand and 3 parts 7mm concrete stone, by mass. The sand proportion may be varied between 1 ½ and 2 ½ to obtain ideal workability."

5.2.2 Benching (Subclause 5.6.2.3)

Replace "1:3 cement mortar" in the first line with "concrete topping consisting of 1 part cement, 2 parts sand and 3 parts 7mm concrete stone, by mass. The sand proportion may be varied between 1 ½ and 2 ½ to obtain ideal workability."

5.2.3 Precast concrete manholes (Subclause 5.6.5)

Replace the contents of this Subclause with the following:

"Precast concrete manholes shall be constructed in accordance with the details shown on the drawings. Joints between chamber sections shall be caulked from the inside with 3:1 sand cement mortar or other sealing method approved by the Employer's Agent."

Add the following new subclauses:

5.2.4 Finished cover level (New Subclause 5.6.7)

"Unless otherwise shown on the drawings or ordered, the level of the top surface of the cover shall be:

- for manholes within carriageways; flush with the final surface of the roadway.
- for manholes within road reserves; 50mm above finished ground level.
- for manholes within midblock; 250mm above finished ground level.
- for manholes within open spaces; 500mm above the finished ground level."

5.2.5 Rectification of water infiltration (New Subclause 5.6.8)

Any infiltration visible in the manhole channels, pipe ends, or benching shall be rectified by demolishing the base and rebuilding.

Rectification of infiltration through the walls and/or joints may be attempted only by externally applied measures, failing which the manhole shall be demolished and re-constructed."

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5.3 CONNECTING SEWERS (SUBCLAUSE 5.9)

5.3.1 Location and details (Subclause 5.9.1)

Delete the following from the first paragraph:

"or required in terms of the Project Specifications"

Delete the second paragraph.

5.3.2 Marker Posts (Subclause 5.9.2)

Replace this Subclause with the following:

"Unless otherwise specified, the Contractor shall supply and accurately place marker posts on the centreline of buried pipelines, or as instructed by the Employer's Agent. Marker posts shall be placed at all points of intersection, chambers and at a maximum spacing of 250 m. Marker posts shall be placed only once the pipelines, or any sections thereof, have been successfully tested and the trenches backfilled.
The co-ordinates, level and centreline distance (as determined from the as-built survey and drawings) of each marker post shall be accurately determined and recorded by the Contractor. All details shall be given to the Employer's Agent in writing."

5.3.1 Connection of New to Existing Reticulation (New Subclause 5.9.4)

The contractor shall under no circumstances connect the new reticulation into the existing without the prior written instruction of the Employer's Agent. This instruction will only be given after acceptance, by the Employer's Agent, of the sewer lines and manholes of the new reticulation upstream of the connection point. Connections will usually be made just prior to the start of the Defects Liability Period.

5.4 INSTALLATION OF CONSERVANCY TANK (NEW SUBCLAUSE 5.11)

Each tank shall be carefully lowered into its excavation and orientated. Thereafter the inlet pipe shall be fitted, and the leakage test carried out (fill tank completely with water and allow to stand and if after three hours there are no signs of leakage, the tank will be deemed to have satisfied the requirements of the test). If tank does not comply with leakage test, it shall be repaired, or removed and replaced with a tank that does comply, as directed by the Employer's Agent.

After acceptance of the tank by the Employer's Agent the excavation shall be backfilled with selected material to the level of the top of digestor tank. The material shall be adequately moistened prior to placing and shall be compacted in layers not exceeding 250mm, care being exercised not to cause any local indentations in the skin of the tank.

The remaining backfill over the top of the tank may comprise of any excavated material and the surface shall be finished off to the shape and level as directed on site."

5.5 BACKFILLING AROUND MANHOLES (NEW SUBCLAUSE 5.12)

Material used to backfill around manholes that fall within the road reserve must comply with Subclause 3.1 of SANS 1200 LB. Material used to backfill around other manholes must comply with Subclause 3.5 of SANS 1200 DB.

Material adjacent to the walls of the manholes must be watered and mixed to its optimum moisture content and compacted in layers not exceeding 150 mm in the compacted state. Compaction must be minimum 100% MOD AASHTO for non-cohesive material, and minimum 93% of MOD AASHTO density for cohesive materials.

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Backfilling around the structure must be carried out in even layers to avoid uneven side forces.

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6 TOLERANCES (CLAUSE 6)

6.1 OVERALL CENTRELINE CONTROL AND MANHOLE LOCATIONS (SUBCLAUSE 6.2)

Replace "±300mm" *in the second line of this Subclause with* "±100mm".

Replace "plus or minus half a pipe length" *in the last line of this Subclause with* "±200mm".

Add the following:

"The Contractor shall note that the positions in plan of manholes are critical. No deviation in excess of the tolerances specified will be accepted without the prior authorization of the Employer's Agent."

Add the following new subclause:

6.2 AS-BUILT INFORMATION (NEW SUBCLAUSE 6.6)

The Contractor shall after completion of a section of pipeline submit the following as-built information:

- Co-ordinates of manholes,
- Invert levels at manholes, and
- Distance between manholes

7 TESTING (CLAUSE 7)

7.1 TESTS AND ACCEPTANCE/REJECTION CRITERIA (SUBCLAUSE 7.2)

7.1.1 Air Test (Subclause 7.2.1)

Add the following:

"After the completion of a successful air test the pipes shall be flushed out to remove all dirt, grit and the like."

7.1.2 Watertightness of manholes (Subclause 7.2.6)

Add the following:

"Manholes will be inspected at the end of the first winter after completion. No ingress of groundwater into the manhole will be allowed.

Should any manhole fail to pass the inspection to the satisfaction of the Employer's Agent, the fault or faults shall be made good by the Contractor at his own expense according to methods approved by the Employer's Agent and the work shall be inspected again. The cost of all extra work and inspection shall be borne by the Contractor."

Add the following new subclause:

7.1.3 Torch and Mirror Test (New Subclause 7.2.7)

The equipment for the test shall comprise of the following:

- A torch capable of emitting a strong beam of light.
- A mirror.
- A wooden plug covered on one side with suitable reflector material. The diameter of the plug shall

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suit the diameter of the pipe being tested.

The test shall be carried out by plugging one end of the pipe with the plug reflector and reflecting the torch beam off the mirror down the pipe from the other end. For the pipeline to be acceptable at least 80% of the plug's reflected area shall be visible."

7.1.4 Acceptance Criteria (New Subclause 7.2.8)

The acceptance of the pipe length or manhole shall depend upon whether it satisfies the criteria set out in clauses 6 and 7 above.

Only tests carried out on the pipelines after completion of the backfilling to ground level (excluding surface restoration) and construction of manholes to roof height and benching will be considered for acceptance purposes.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Supply, lay, joint, bed and test pipeline (Subclause 8.2.1)

Add the following:

"The rate tendered shall further cover the cost of providing the water and for flushing out the pipeline as called for in terms of subclause 7.2.1, as well as for the disposal of the water.

The measured quantity of completed pipe length will only be included in the payment certificate when pipeline has satisfied the test after the completion of the backfill to ground level – see subclause 7.2.8. Prior to this, payment will be made as materials on site."

8.1.2 Extra over item 8.2.1 for specials (Subclause 8.2.2)

All specials shall include for the provision of couplings as required.

8.1.3 Manholes (Subclause 8.2.3) ..... Unit: No

Add the following to the end of this Subclause:

"The rates tendered for the manholes shall cover the supply and installation of the complete manhole, castings, step irons, benching, frame and concrete footings for the prevention of filtration where applicable.

For the purpose of measurement and payment, the depth of a manholes is defined as the depth from the top of the cover to the invert level of the manhole."

8.1.4 Inspection chambers, etc. (Subclause 8.2.5)

Replace the contents of this Subclause with the following:

"Separate items will be scheduled for manholes, backdrops, and inspection chambers, etc of each type and of each depth in increments of 0,5 m. The rate shall cover the cost of dealing with any excavation (in all materials including disposal of surplus) and backfilling with suitable material in accordance with 5.11 (New Subclause) (including import of material if required) additional to what is measured under Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB. The rate shall cover the cost of construction of manholes complete with

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channels, benching, short pipes (1 m long) and all flexible connections in accordance with the detail shown on the drawings. The depth category of manholes shall be measured as the difference between the cover level and the deepest invert level of the manhole."

8.1.5 Erf connections (Subclause 8.2.6)

Replace the contents of the two paragraphs with the following:

"a) Connections to sewer ..... Unit: No.

Separate items will be listed for connections measured at different depths. The depth will be that of the main sewer at the point of connection. The size, type, class and treatment of the junction and bend shall be the same as for the connection pipe.

The rate shall cover the cost for excavation in all materials, bedding and backfilling (including importation of suitable material if required), disposal of surplus, supply and installation of a junction with erf connection entering the main sewer line flush with the soffit of the main sewer, 45-degree bend and the end cap.

b) Connections to sewer manhole ..... Unit: No.

The rate shall cover the cost for adapting a standard manhole to accommodate the erf connection pipe, and the supply and installation of the end cap."

8.1.6 Connection to Existing Sewer at (Subclause 8.2.11) ..... Unit: No.

Replace the contents of this Subclause with the following:

"The tendered sum shall include full compensation for excavation, making an opening in the existing manhole, installing new pipes in the new opening, for breaking out and modifying the channelisation inside the manhole to suit the new pipe layout, ensuring the watertightness of the new connection, supplying all the necessary materials, removing surplus material and debris, all labour and equipment required to make the connection, and liaison with the local authorities."

8.1.7 Watertightness of Manholes (New Subclause 8.2.13) ..... Unit: No.

"The tendered rate shall include full compensation for ensuring the manholes are watertight after the connections have been made, including all materials/products required to ensure total sealing/waterproofing around the pipe inlets into the structure and all testing as may be required by the contractor to verify the watertightness of the manhole."

8.1.8 Construction of Rodding Eye concrete surround 200x200x75mm thick (New Subclause 8.2.14) ..... Unit: No.

"The rate shall cover all costs for the supply and installation of the complete rodding eye as per the detail drawings, including all excavation, materials, labour, backfill material (as required), compaction around the structure and ensuring the necessary safety requirements are adhered to."

8.1.9 Provide, test, and install conservancy tank complete with internal specials (Tank type specified) (New Subclause 8.2.15) ..... Unit: No.

The rate tendered shall cover the additional cost, extra over that provided for under item 8.2.3, to construct a manhole on an existing line, the breaking and trimming of the existing pipe, any additional work involved to construct the benching, dealing with existing flow, preventing foreign material entering the sewer as well as making good any work disturbed."

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1 SCOPE (CLAUSE 1)

No Amendments.

2 INTERPRETATION (CLAUSE 2)

No Amendments.

3 MATERIALS (CLAUSE 3)

3.1 CULVERT UNITS AND PIPES (SUBCLAUSE 3.1)

Add the following to the end of subclause 3.1c):

"Precast concrete units shall comply with the requirements of the latest SANS 986:2006 specification.

Prior to the manufacture of any units the manufacturer shall submit his Quality Plan to be approved by the Employer's Agent before delivery of any units to site. As part of the Quality Plan submitted for approval copies of calibration certificates of both gauges used for proof loads and cover meters used at the factory shall be supplied to the Employer's Agent. The originals of these certificates shall at all stages also be available for inspection at the factory premises. The manufacturer shall check each precast unit for cover compliance, and random checking of units shall not be permitted. The Employer's Agent's representative may visit the factory at any stage to ascertain adherence to the quality plan as well as to check covers before delivery to site. Any substandard cover shall result in the batch being rejected. Should the manufacturer not be adhering to their Quality Plan the Employer's Agent may exercise the right to reject the use of products from the manufacturer concerned. The employer shall also be informed in all such cases."

Add the following to the end of subclause 3.1d):

"Skewed ends for pipe culverts may be cut on Site."

3.2 MANHOLES, CATCHPITS, AND ACCESSORIES (SUBCLAUSE 3.4)

3.2.1 Bricks (Subclause 3.4.1)

Add the following:

"Bricks shall be engineering bricks complying with the requirements of SANS 227."

3.3 MATERIALS FOR SUBSURFACE DRAINS (NEW SUBCLAUSE 3.6)

a) Pipes and fittings

Pipes for subsurface drains shall be normal duty, perforated or slotted uPVC pipes complying with SANS 791. Fittings shall be heavy duty and shall also comply with SANS 791.

The size of the perforations in perforated pipes shall in all cases be 8 mm in diameter ± 1,5 mm, and the number of perforations per metre shall not be less than 26 for DN110 pipes, 52 for DN160 pipes, and 104 for DN315 pipes. Perforations shall be spaced in two rows for 110 mm pipes, in four rows for 160 mm pipes, and eight (8) rows for DN315 pipes, or as shown on the Drawings.

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Slotted pipes shall have a slot width of 8 mm with a tolerance of 1,5 mm in width. The arrangement of the slots is subject to the Employer's Agents approval, but the total slot area shall not be smaller than that specified for perforations.

b) Crushed stone

Crushed stone shall be 19 mm single-sized and shall comply with the requirements of SANS 1083.

c) Geotextiles

Geotextiles shall be a non-woven, spun or thermic-bonded continuous filament fabric consisting of at least 85% by mass of polypropylene, polyester or other approved material and manufactured for civil-engineering applications by a recognised manufacturer.

4 PLANT (CLAUSE 4)

No Amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 TRENCH BOTTOM (SUBCLAUSE 5.1)

5.1.1 Width of excavation (SUBCLAUSE 5.1.4)

Add the following to the end of subclause 5.1.4a):

The base width of rectangular portal culverts shall be used to determine the side allowance as per SANS 1200 DB subclause 5.2.

5.2 BEDDING AND LAYING (SUBCLAUSE 5.2)

5.2.1 General (subclause 5.2.1)

With reference to the last sentence of the second paragraph of this Clause and without limiting the Contractor's responsibility in this regard, the minimum depth of cover during construction shall be as specified by the pipe manufacturer.

5.2.2 Pipe Culverts (subclause 5.2.2)

Add the following:

"Unless otherwise stated in the Bill of Quantities or indicated on the drawing, spigot and socket pipes with rubber ring seals shall be used.

Pipes with ogee joints shall be wrapped with two layers of Hessian soaked in cementitious grout. The wrapping shall be 400mm wide and placed centrally over each joint.

Where pipes are cut, the ends shall be made good with an epoxy concrete mix so as to prevent rusting of the reinforcement or deterioration of the concrete.

Lifting holes should be suitably closed off to prevent the ingress of soil."

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5.3 PORTAL AND RECTANGULAR CULVERTS (SUBCLAUSE 5.2.5)

Add the following to the end of Subclause 5.2.5b):

Where rectangular portal culverts are inverted, a 300mm selected granular material shall be placed at the base of the inverted culvert.

"Rectangular culvert joints shall be sealed with a 500 mm wide strip of Bituthene 3000 or an approved equivalent material glued symmetrically around the joint, using an adhesive recommended by the manufacturer of Bituthene. A 150 mm wide strip of adhesive shall be applied to the edges of the Bituthene."

5.4 CATCHPITS, MANHOLES, INLETS, AND OUTLET STRUCTURES (SUBCLAUSE 5.5)

5.4.1 Benching (Subclause 5.5.6)

Delete "granolithic plaster" *and replace by* "concrete topping consisting of a 1:2:3 cement, sand and 7mm stone mix by weight. The sand proportion may be varied between 1,5 and 2,5 to obtain ideal workability.

Add the following New Subclauses:

5.5 SUBSURFACE DRAINS (NEW SUBCLAUSE 5.8)

Subsurface drains shall be constructed where shown on the Drawing or as ordered by the Employer's Agent to the detail as shown on the Drawings.

After the completion of the excavations, the bottom portion of the trench shall be lined with geotextile sheeting as shown on the Drawings. The top edges of the vertical portions of the geotextile sheeting shall be tacked to the sides of the excavations with nails or by another suitable approved means. An overlap of at least 300 mm shall be provided at each joint. Geotextile sheeting damaged during the installation or construction shall be replaced at the Contractor's cost.

A layer of crushed stone of the thickness shown on the Drawings shall be placed on the geotextile and be lightly tamped and finished to the required gradient.

Pipes of the required size shall be firmly bedded on the permeable material, true to level and grade, and coupled where required. The trench shall then be backfilled with crushed stone to the height above the pipes shown on the Drawings or as directed by the Employer's Agent.

Crushed stone shall be placed in layers of not more than 300 mm at a time and shall be lightly compacted. Care shall be taken to prevent the contamination of crushed stone during construction of the subsurface drains and all material contaminated by soil or silt shall be removed and replaced by the Contractor at his own expense.

Perforated and slotted pipes shall be joined by couplers. Perforated pipes shall be laid with the perforations at the top or at the bottom, as directed. The higher end of subsurface drain pipes shall terminate at an inspection chamber or rodding eye, as shown on the Drawings and at the lower end of the pipe shall be built into a concrete head wall providing a positive outlet, or it shall be connected to the storm water pipes or culverts.

After all the crushed stone filter material has been placed, the protruding vertical filter material has been placed, the protruding vertical sections of the geotextile sheeting shall be folded back across the filter material so that the filter material will be completely enwrapped in the geotextile. An overlap of at least 200 mm shall be provided between the portions folded back.

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The remainder of the trench shall be immediately backfilled with approved impermeable material preferably obtained from the excavations, in layers not exceeding 150 mm and compacted to 90% of modified AASHTO density, unless otherwise ordered by the Employer's Agent. The trench shall be specially protected against the ingress of water, soil and silt until the backfilling with impermeable material has been completed. Permeable material in subsoil drains shall not be taken to the surface but shall be discontinued at such heights as will be determined by the Employer's Agent.

Any section of a subsurface drain constructed with pipes without perforations or slots shall be backfilled with impermeable backfill material as described above. Suitable excavated material may be used for backfilling. Payment for excavations as well as for backfilling with impermeable material will be made under SANS 1200 DB.

5.6 BACKFILLING AROUND STRUCTURES (NEW SUBCLAUSE 5.9)

Material used to backfill around manholes that fall within the road reserve must comply with Subclause 3.1 of SANS 1200 LB. Material used to backfill around other manholes must comply with Subclause 3.5 of SANS 1200 DB.

Material adjacent to the walls of the manholes must be watered and mixed to its optimum moisture content and compacted in layers not exceeding 150 mm in the compacted state. Compaction must be minimum 100% MOD AASHTO for non-cohesive material, and minimum 93% of MOD AASHTO density for cohesive materials.

Backfilling around the structure must be carried out in even layers to avoid uneven side forces.

6 TOLERANCES (CLAUSE 6)

Add the following new Clause:

6.1 PIPES INTO MANHOLES / CATCHPITS (NEW SUBCLAUSE 6.6)

Pipes may protrude up to 300mm into a manhole / catchpit. This relaxation will only be permitted if the pipe does not have to be cut. The "dead space" formed at the end of the manhole is to be suitably benched off to prevent the collection of silt and rubbish."

Add the following new Clause:

6.2 AS-BUILT DETAILS (NEW SUBCLAUSE 6.7)

The Contractor shall submit as-built levels, distances between manholes and the grades of pipelines for which he requires payment, at the time he submits his monthly payment claim. A sample form is obtained from the Employer's Agent."

7 TESTING FOR LEAKAGE (CLAUSE 7)

No Amendments.

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8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Supply and Lay Concrete Pipe Culverts: (Subclause 8.2.1)

Replace the heading of the Subclause with the following:

"**Supply, lay, joint, bed and test pipeline:**"

Replace the contents of the Subclause with the following:

(a) Reinforced concrete pipes type SC Spigot & Socket pipe with rubber ring joints on sand bedding of diameters & class as indicated.....Unit : m"

Notwithstanding the stated provisions, bedding will be measured for payment in terms of the appropriate clauses of SANS 1200 LB..

8.1.2 Supply and installation of manholes, catchpits, and the like (Subclause 8.2.8)

In the heading of this Subclause, replace the words "and the Like" *with* "grid inlets, headwalls, inspection chambers, rodding eyes and the like".

Add to the contents of Clause 8.2.8 the following:

"(d) Inlets (type and depth range stated)

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures."

"(e) Headwalls (type and depth range stated)

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures."

"(f) Gulleys (type and depth range stated)

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures."

"(g) Variable outlet structures (type and depth range stated)

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures."

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[redacted]

Replace the contents of the Subclause with the following:

"For the purpose of measurement and payment, the depth of a manhole, catchpit, etc., is defined as the depth from the top of the cover to the invert level of the manhole, catchpit, etc. (where the invert level for larger manholes, catchpits, etc. is that of the main floor area and not the invert of a localized recess used for draining the manhole, catchpit, etc.).

Separate items are listed for manholes, catchpits, etc. with depth increments (if applicable) and type. The rate shall cover the cost of any excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required), additional to what is measured under the relevant pipe trench item (refer to Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB). The rate shall further cover the cost of building the manholes, catchpits, etc., complete as shown on the relevant drawings, including step irons, cover and frames (Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all materials, plant and labour."

Add the following New Subclauses:

8.1.3 Supply and install subsurface drains (New Subclause 8.2.14).....Unit: m

Depending on the conditions where subsurface drains are to be constructed, they will be scheduled and measured, at the discretion of the Employer's Agent, either by individual items for excavation and for the supply and installation of the materials required for the drains, or by a single rate per metre length or square meter area of drain constructed.

Where a single rate per metre length or square meter is scheduled, the tendered rate shall cover the cost of excavation, disposal of surplus material, supply of all material, labour, plant and incidentals to complete the construction of the subsurface drain as shown on the drawings.

The rate shall cover all costs for the supply and installation of the complete subsurface drains as per the detail drawings, including excavation, backfill, spoiling excess material, geotextile, stone and pipework.

8.1.4 Supply and install rodding eye for subsurface drains (New Subclause 8.2.15)..... Unit: No

The rate shall cover all cost for the supply and installation of the complete rodding eye as per the detail drawings.

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1 SCOPE (CLAUSE 1)

Replace the contents of this subclause with the following:

"The Scope covers the insertion, by jacking, micro tunnelling and directional drilling, underneath roads, railways and river crossings without disturbing the surface or interfering with the normal flow of traffic"

2 INTERPRETATIONS (CLAUSE 2)

2.1 SUPPORTING SPECIFICATIONS (SUBCLAUSE 2.1)

Delete from Subclause 2.1(b), "or SANS 1200 AA, as applicable" *and throughout the specification delete all references to SANS 1200 AA.*

Delete from Subclause 2.1(c), "or SANS 1200 DA, as applicable" *and throughout the specification delete all references to SANS 1200 DA.*

Delete from Subclause 2.1(d), "or SANS 1200 GA, as applicable" *and throughout the specification delete all references to SANS 1200 GA.*

Add the following:

"h) SASTT Technical standard, trenchless construction works, Part TT3: Horizontal directional drilling, as published by the South African Society for Trenchless Technology (SASTT)"

2.2 DEFINITIONS (SUBCLAUSE 2.3)

Add the following definitions:

""The Works shall mean all the features making up the entire trenchless operation including construction of both launch and receiving pits as well as the excavation placing and insertion of the pipes together with all support activities.

Pipe ramming. The installation of steel casing pipes by driving/hammering into position. The material within the steel pipe sleeve is then removed, via the pipe, by hydraulic or mechanical methods. The permanent pipe or cable is then installed inside the steel sleeve.

Horizontal boring. The installation of pipes and cables on a constant grade and alignment, by pulling them into position behind a hydraulically or pneumatically powered cutting or hammer head. The material displaced by the head is either displaced sideways or removed, via the pipe, by hydraulic or mechanical methods.

Directional drilling. The installation of pipes and cables on a variable grade and alignment, by pulling them into position behind a hydraulically or pneumatically powered traceable and steerable cutting or hammer head. The material displaced by the pipe is either displaced sideways or removed, via the pipe, by hydraulic or mechanical methods.

Pipe jacking. The installation of large diameter pipes by pushing the pipe into position whilst excavating ahead of the pipe by hand, mechanical method or tunnelling.

Micro tunnelling technology. Full-face excavation machine which uses a hydraulic slurry circuit to remove debris from the cutter head to a desanding plant. The machine is capable of working in most geotechnical conditions and without the need of drawing down the groundwater table."

3 MATERIALS (CLAUSE 3)

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3.1 PIPES (SUBCLAUSE 3.1)

Delete the sub clause and substitute with the following:

"Pipes for directional drilling shall be HDPE PE100 pipes or as specified conforming to the requirements of subclause 3.7.2 of SANS 1200 L. The directional drilling contractor shall advise if the stiffness rating/pressure class of the pipe needs to be increased. The HDPE pipe shall be joined by means of butt-welding as detailed in the subclause 5.2.5 of SANS 1200 L.

Pipes for jacking shall be SI Type reinforced concrete manufactured in accordance with SANS 677 to the D load specified on the drawings. All pipe joints shall be in-the-wall joints with a cast in steel band that provides a watertight seal. The actual diameters of the pipes shall not be less than the nominal diameters given on the drawings or stated in the schedule.

In addition to withstanding the specified two (or three), edge bearing test-load, the pipes shall be capable of withstanding, without damage during jacking, the maximum longitudinal force to be transmitted by the Contractor's jacks and method of installation.

The details of the pipes to incorporate the jacking shield and interjack stations shall be determined by the Contractor to suit the proposed method of construction. The pipe class of these pipes shall not be less than the class of pipe or type of pipe stated on the drawings or determined by the Employer's Agent. The Contractor must adhere to the joint sealing details given in Subclause 3.1.2 below.

At least one hole shall be formed in the crown of each 2.4m long pipe to allow for the injection of both a lubricant, if required, and a final grout. The final layout of grout holes is the Contractor's responsibility.

The Contractor must ensure that the pipes shown on the drawings and mentioned in the documents can be jacked the full distance shown on the drawings.

Add the following new subclauses:

3.1.1 Intermediate jacking pipes (New Subclause 3.1.1)

In circumstances where it is necessary or desirable to use interjack stations, jacking pipes between manholes or junctions, the number and type of such intermediate jacking pipes is to be determined by the Contractor. The joint between pairs of intermediate jacking pipes shall be protected externally by a cylindrical mild steel sleeve of wall thickness at least 8mm, which shall overlap the pipes on either side of the joint for a distance of at least 150mm. The final joint is to include a substantial and permanent caulked seal within the joint.

3.1.2 Joints and seals (New Subclause 3.1.2)

It is the Contractor's choice as to type of joint used in the pipes to be jacked. However, applied forces used to jack the pipes must be uniformly distributed around the joint to avoid damaging the joint. Pipes that are delivered to site with damaged joints must be rejected by the Contractor.

A seal is required at each joint to minimise ingress of water. Ingress of water into a jacked section of pipes stemming from the joints shall not exceed 5 litres per minute in total. The chipboard packing used to distribute stresses on the joints should be raked out to a depth of 25mm on the inside all round and sealed with a durable flexible sealing agent such as bituseal, thioflex or similar.

3.2 INTERMEDIATE JACKING STATIONS (SUBCLAUSE 3.2)

Delete the sub clause.

4 PLANT (CLAUSE 4)

No amendments.

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5 CONSTRUCTION (CLAUSE 5)

5.1 GENERAL (SUBCLAUSE 5.1)

5.1.1 Authority to jack pipelines under facilities controlled by Third Parties (Subclause 5.1.1)

Add the following:

"The Employer will obtain permission from the relevant authorities for jacking under roads. However, the Contractor is to confirm that such permission has been granted at least 14 working days before commencing work."

5.1.2 Competence (Subclause 5.1.2)

Add to the sub clause:

"Jacking, micro tunnelling, directional drilling and excavation shall be supervised and undertaken by persons fully conversant with this work. (Clause 4.11 and 4.12 of the GCC 2015)."

5.1.3 Design calculations by Contractor (Subclause 5.1.3)

Add to the sub clause:

"The Contractor shall for each crossing supply the following information to the Employer's Agent within 14 days of receipt of the Letter of Acceptance:

a) All the necessary sleeve pipe characteristic details i.e. class etc.

b) The maximum forces that can be applied during the operation.

c) Full design details and calculations which much include expected loads pertaining to the sleeve sections he proposes to use, where protection to the sleeve pipe is required, full details including referenced design details which must be generally in accordance with SANS 10102-1 and 10102-2 and drawings etc., must be included.

d) Details of calculations and drawings of the proposed method of load transfer from the pipe to the thrust pit wall.

e) The proposed method of working – i.e. the position of the thrust and reception pits, size and number of jacking points he intends using.

f) Full details of the joint sealers, sleeves and methods of lubrication and grouting to be employed.

g) Full details and sketches of the proposed method to be used to seal the joints at intermediate jacking stations, if applicable.

h) Full details of stabilising unstable areas and grouting of voids.

The design calculations and drawings shall be signed by a Registered Professional Civil Engineer responsible for the designs.

The Contractor shall not commence any pipe jacking work shown on the drawings or specified in the specifications until the Employer's Agent has authorised in writing that the work may proceed."

5.1.4 Contractor solely responsible (Subclause 5.1.4)

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Add to the sub clause:

"No approval of any material or plant and its operation, or of any construction procedure to be used will imply any relaxation of the requirements governing the quality of the materials or of the finished work or relieve the Contractor of his/her responsibilities under the Contract."

5.2 SAFETY CONTROL REQUIREMENTS (SUBCLAUSE 5.2)

5.2.1 Recording movements (Subclause 5.2.3)

5.2.1.1 General (Subclause 5.2.3.1)

Delete the sub clause and substitute with the following sub clause:

"The Contractor shall take movement measurements correct to 1,0 mm of accuracy of any change in the line and level of road before the start of the Contract and at such intervals as directed by the Employer's Agent for a period up to 12 months after issue of the Completion Certificate. However, no more than 15 sets of reading will be required in this period. A copy of these measurement records shall be made available to the Employer's Agent. The cost of this work is deemed to be included in the tendered rates."

5.2.1.2 Working under roadways (Subclause 5.2.3.2)

Add to the sub clause:

"The Contractor shall bear full responsibility for any consequential damage to persons and property resulting from subsidence."

5.3 EXCAVATION (SUBCLAUSE 5.4)

5.3.1 General (Subclause 5.4.1)

Add to the sub clause:

"Except as required in terms of 5.2.5 SANS 1200 LG 1983, the provisions of SANS 1200 D shall apply."

5.3.2 Thrust pit (Subclause 5.4.2)

In the second paragraph, delete the words "Factories, Machinery and Building Work Act, 1941 (Act 22 of 1941)" *and replace with the words* "Occupational Health and Safety Act 1995".

Add to the sub clause:

Claims arising out of any accidents or incidents in or adjacent to these access pits will not be considered by the Employer.

Stormwater control measures around these pits are also necessary to prevent water ingress into the pits. Provision must be made by the Contractor to keep these pits free of seepage and stormwater.

Thrust pits will in general only be permitted at positions indicated on the drawings or where manholes or junctions are required or as agreed on Site by between the Contractor and the Employer's Agent. Jacking pits shall be of sufficient size to accommodate the jacking operation and any manhole structure to be constructed upon completion of the jacking. The approximate dimensions of the pits shall be agreed with the Employer's Agent before work commences. The Contractor will be required to design and construct all thrust blocks, bases and other temporary works required to maintain the stability of the pits and shall demolish and remove these upon completion of the jacking operation and the Contractor shall take into account all such limiting factors when preparing his/her tender.

5.3.3 Jacking of pipeline (Subclause 5.4.3)

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5.3.3.1 General (Subclause 5.4.3.1)

Add to the sub clause:

A lead pipe with a rebated front end over which the trailing end of the shield is fitted should be the first concrete pipe used. This should minimise overbreak. No material may be removed in advance of the leading edge of the shield in unstable or loose materials.

As the pipe is advanced, excavation is to take place within the shield attached to the lead pipe under the full-time supervision of a responsible foreman to ensure that the end of the shield is always fully plugged with earth at a safe angle of repose within the pipe. The Contractor shall ensure that there is not uncontrolled flow of sand, mud or earth into the pipe which could result in imperilling excavation personnel or the formation of cavities above or around the sleeve pipe. If at any stage during the jacking operation such conditions arise the Contractor shall immediately plug the pipe and stabilise the material before proceeding with further work.

Should it be necessary, the Contractor shall allow for stabilising the soil by dewatering, chemical grouting, or any other approved means. The design of the shield shall be such as to permit the face to be completely or partially closed by boarding or similar to control material flow from the face.

During weekend or holiday stoppages the Contractor must make sure that a plug of soil is left in the shield.

Add to the sub clause:

5.3.3.2 Continuous operation (New Subclause 5.4.3.6)

In order to minimize problems due to the build-up of skin friction on a static pipe, the pipes are to be jacked continuously unless agreed to otherwise with the Employer's Agent. Adequate lighting shall be provided by the Contractor at night.

5.4 JACKING PROCEDURE (SUBCLAUSE 5.5)

5.4.1 Procedure (Subclause 5.5.1)

Add to the sub clause:

Each jack shall be fitted with a pressure gauge suitably calibrated such that the actual jacking forces can be read at any time.

Suitable packing of hard material shall be attached to the concrete face at the trailing vertical ends of the pipes in order to transfer the jacking force. The packing shall constitute a complete circle and be sufficiently wide to transfer the applied load.

A suitable steerable shield is to be fitted to the front of the lead pipe. The shield is to incorporate a cutting edge which can be controlled by jacks to maintain the pipe on line and level.

Pipe jacking is generally carried out up-grade. The Contractor may choose to do otherwise. This will be subject to the approval of the Employer's Agent. Provision must be made by the Contractor for the necessary drainage required.

5.4.2 Lubrication of structure during jacking (Subclause 5.5.1)

Add to the sub clause:

"To ease pipe friction, the Contractor shall make provision for the injection of bentonite or other approved lubricant."

5.5 BACKFILLING AND DISPOSAL OF EXCAVATED MATERIAL (SUBCLAUSE 5.6)

Add the following sub clause:

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5.5.1.1 Backfilling (New Subclause 5.6.1)

"Both thrust and reception pits must be backfilled using the removed material. Backfill compaction rates must not be less than 90% Modified AASHTO with the top 1,5 m of backfill being compacted to a minimum 93% Modified AASHTO. The backfill must be built up to at least 300 mm above the natural ground level to prevent stormwater pounding around the excavation pits."

5.6 GROUTING AND PLUGGING (SUBCLAUSE 5.7)

Add to the sub clause:

"In soft material the grout shall consist of cement/bentonite with a compressive strength of 5MPa at 28 days. In hard material and rock the grout shall consist of cement/sand with a compressive strength of 25 MPa at 28 days.

Where a product pipe is to be installed in a jacked sleeve pipe and where indicated on the drawings, a stabilized sand/cement grout shall be injected to fill the void between the product pipe and the jacked pipeline. Unless specified otherwise elsewhere, the grout shall have a strength equal to or better than a mixture consisting of one part cement and six parts sand, and shall have a slump of 150 mm."

5.7 AS-BUILT DRAWINGS (SUBCLAUSE 5.8)

Add to the sub clause:

"The Certificate of Completion will not be issued until the Contractor has supplied to the Employer's Agent, A1 size drawings showing details of the completed jacked pipeline. Each such drawing shall be certified by the Contractor to be an accurate reflection of the details of the work as constructed."

Add the following new subclauses:

5.8 MARKERS (NEW SUBCLAUSE 5.9)

On completion of the backfill the Contractor must place a concrete marker post (prestressed lintel) into the ground directly above the centre line of the pipe at each end of the installed sleeve pipe. This shall be painted with a weatherproof pain and be labelled as required by the Employer's Agent.

5.9 REMEDIAL MEASURES (NEW SUBCLAUSE 5.10)

All remedial measures will be carried out and completed to the standards set by the various controlling authorities.

Roads – remedial measures plus time related professional costs needed to reinstate roads and fill embankments will be the Contractor's liability.

Remedial measures are those relating to the need to put right settlement and movement of road surfaces, formation layers or fill embankments including providing all road safety markers, traffic control, or signs and all associated needs of the road authority to allow remedial work to proceed without danger to workers or traffic. The Contractor must arrange all matters regarding remedial work with the road authority. In most instances these measures will comprise jacking up concrete roads using grout and re-grading to original elevation formation layers and premix surfacing as well as mending drainage fixtures where these have been damaged. All the remedial work will be directed by the Employer's Agent to his satisfaction and approval.

5.10 BRICKING UP OF SLEEVE ENDS (NEW SUBCLAUSE 5.11)

Upon completion of the jacking, the Contractor shall brick up the sleeve ends to prevent ingress of sand.

6 TOLERANCES (CLAUSE 6)

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6.1 PERMISSIBLE DEVIATIONS (SUBCLAUSE 6.2)

In the first line delete "100 mm" *and substitute with* "50 mm".

6.2 CHECKING ALIGNMENT (SUBCLAUSE 6.3)

Add to the clause:

"A copy of the results of all checks together with a statement detailing corrective measures taken shall be available for inspection on Site at all times and further copies shall be submitted to the Employer's Agent on a weekly basis."

Add the following sub clause:

6.3 MEASUREMENT (NEW SUBCLAUSE 6.4)

Throughout the jacking operation the Contractor is requested to take and record the following measurements.

a) A plot of pressure (kN/m²) and total force (kN) originating from the combined force of all hydraulic jacks used to move pipes versus accumulative length of jacked pipe. As soon as a lubricant is used it must be recorded on the plot. If heavy ground water seepage is noted this must also be recorded on the plot. A time scale in days should also be used in conjunction with jacked length of pipe. It is also important to record start up force required to move pipes after a delay, i.e. after weekend.

b) The dimensions of the thrust block used must be recorded as well as the accumulative thrust force on the block (kN) together with any movement of the thrust block (mm).

7 TESTING (CLAUSE 7)

No amendments

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Supply of pipes to be jacked (Subclause 8.2.2) ..... Unit: m

Add the following sub clause:

The unit of measurement for supply of pipes to be jacked shall be the metre of pipe and will be measured between ends of the completed pipeline. The measurement shall include intermediate jacking pipes.

The rate shall cover the cost of supplying selected pipes with grouting holes, delivering, handling, storing of pipes, rubber rings, packing pieces and flexible sealing to joints between intermediate jacking pipes.

8.1.2 Jacking of pipes (Subclause 8.2.3) ..... Unit: m

In the first paragraph add the word "Grouting" *before the words*" sealing grouting holes..."

8.1.3 Supply and install pipes by pipe jacking method, complete with excavations (Subclause 8.2.6) ..... Unit: m

In the first paragraph, delete the words "up to 85 m".

Add to the sub clause:

"The rate shall include for grouting all voids around the jacking pipe annulus which are a result of the pipe jacking operation."

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8.1.4 Extra-over 8.2.6 for lengths of pipeline greater than 85m (Subclause 8.2.7)

Delete the sub clause

8.1.5 Stabilisation of unstable areas or grouting of voids where ordered (Subclause 8.2.9)

Delete the clause.

8.1.6 Standing time for pipe jacking gang and the jacking equipment (Subclause 8.2.10) ..... Unit: hour

In the first paragraph, delete the words "Wage Act, 1957 (Act 5 of 1957)" *and replace with the words* "Basic Conditions of Employment Act No. 75 of 1997".

Add to the sub clause:

8.1.7 Recording movements (New Subclause 8.2.11) ..... Unit: No.

The unit of measurement will be per visit and set of readings taken (5.2.3 above).

The rate shall cover for all labour, equipment, as well as plotting up of the reading for presentation to the Employer's Agent.

8.1.8 Brick wall closure (New Subclause 8.2.12)..... Unit: No.

The unit of measurement will be the number per jacked pipe diameter.

The rate shall cover all labour, materials and equipment used to construct the brickwork ends at each end of each jacked pipe after the installation of the steel water pipe through the sleeve.

The rate for foundations to brickwork walls shall be per cubic meter of concrete measured net as per design, including all excavation, formwork, backfill, etc to produce a complete foundation ready to receive the brickwork.

8.1.9 Markers (New Subclause 8.2.13) ..... Unit: No.

The unit of measurement will be the linear meter of concrete lintel marker.

The rate shall cover all labour, equipment and paint to place the markers at the end of pipes."

8.1.10 Grout infill between product pipe and jacked sleeve (New Subclause 8.2.14)..... Unit: m^3

This rate applies solely to filling the gap between a product pipe and its jacking sleeve. Any other grouting shall be included in the rates as specified elsewhere.

The rate shall cover all labour, materials and equipment used to inject grout to fill the void between the product pipe and jacked sleeve.

The unit of measurement will be per cubic meter by subtracting the product pipe's volume from the jacking sleeve's internal volume. No extra payment is provided for wastage.

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

No amendments.

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

No amendments.

6 TOLERANCES (CLAUSE 6)

Add the following to :

6.1 DIMENSION AND LEVEL CONTROL OF ROAD LAYERS (NEW SUBCLAUSE 6.4)

The Contractor shall submit to the Employer's Agenta record of the surface levels of the section of layer under consideration, prior to requesting inspection and acceptance control testing. The levels shall be taken at meterage and co-ordinate intervals that coincide with those given on the drawings, in accordance with the requirements of subclause 6.3."

7 TESTING (CLAUSE 7)

7.1 GENERAL (SUBCLAUSE 7.1)

Add the following to the Subclause:

"The random sampling method of TMH 5, for the spotting of positions, for field density testing will not necessarily be applied by the Employer's Agents Representative. Density testing shall be carried out where, in his opinion, the density of the compacted layer is suspect."

The Contractor shall further present the full width of the layer between the stated linear stake values for acceptance - only in exceptional cases may partial widths be presented.

7.2 PROCESS CONTROL (SUBCLAUSE 7.2)

Add the following to the Subclause:

"The process control required of the Contractor shall be carried out by an independent testing laboratory approved by the Employer's Agent."

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7.3 ROUTINE INSPECTION AND TESTING (SUBCLAUSE 7.3)

Add the following to Subclause 7.3.1:

"All requests for acceptance control testing shall be submitted in writing to the Employer's Agent. Each request shall clearly specify the location of the section and the description of the layer and shall be accompanied by the dimension and level control data for the section under consideration (refer subclause 6.4), as well as the results of the Contractor's process control testing (refer subclause 7.2). On receipt of the aforementioned the Employer's Agent will undertake, or arrange as the case may be, for the necessary inspection and acceptance control tests to be carried out to satisfy himself that the layer complies with the specification.

Testing will be carried out as expeditiously as possible and the results of tests made available within 48 hours from the time the request was made, plus the normal time required doing the test.

The written approval of the submitted section of a layer shall be obtained from the Employer's Agent before the Contractor may proceed with the placing of material for the following layer. The Contractor shall also, before proceeding with the placing of the material for the following layer, make good any test holes left in the layer using material complying with the specification for that layer and compacting it to the specified density for that layer, concrete shall not be used."

Substitute subclause 7.3.3 with the following:

"Statistical evaluation of test results shall not be allowed, and all tests shall meet the specified minimum requirements."

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 ACCEPTANCE CONTROL TESTING (NEW SUBCLAUSE 8.2)

Should the layer submitted for acceptance control testing fail to comply with the specification, the Contractor shall, in the case where the tests arranged for by the Employer's Agent were carried out by a designated laboratory (refer subclause 7.2), bear the invoiced cost of the tests. Conversely if the layer is found to comply with the specification the cost of the acceptance control tests will be borne by the Employer. The cost of refilling and compacting the test holes shall be covered by the rate tendered for the construction of that layer.

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1 SCOPE (CLAUSE 1)

Add the following to Subclause 1.1:

"All the requirements as specified for the construction of subbase shall, except where otherwise stated or ordered, apply to the stabilization of the in-situ material as new subbase."

2 INTERPRETATIONS (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

3.1 PHYSICAL PROPERTIES (SUBCLAUSE 3.2)

3.1.1 Subbase material (Subclause 3.2.1)

Replace the contents of paragraph (a) with the following:

"(a) The maximum particle dimension of the gravel shall not exceed 63 mm."

Replace the contents of paragraph (d) and (e) with the following:

"(d) The CBR at specified density shall be 45 for unstabilized material as well as for stabilized material *prior to stabilization."*

The UCS at 7 days of each cement-stabilized material shall at 100% modified AASHTO maximum density be as follows:

- For C3 cemented natural gravel: 1,50 MPa minimum and 3,00 MPa maximum
- For C4 cemented natural gravel: 0,75 MPa minimum and 1,50 MPa maximum

(e) The ITS (Indirect Tensile Strength) for cement-stabilised material shall at 100% modified AASHTO maximum density be as follows:

- For C3 cemented natural gravel:250 kPa minimum
- For C4 cemented natural gravel:200 kPa minimum."

3.1.2 Gravel shoulder and gravel wearing course material (Subclause 3.2.2)

Replace the contents of this subclause with the following:

"The material used for gravel shoulders and gravel wearing course shall comply with the following:
(a) The PI shall not be less than 6 and not more than (3 x GM) + 10.
(b) The maximum particle dimension of the gravel shall not exceed 40 mm.
(c) The CBR shall be greater than 15 at 93% of modified AASHTO density."

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3.2 STABILIZING AGENT (SUBCLAUSE 3.3)

3.2.1 General (Subclause 3.3.1)

Add the following to this Subclause:

"Where reference is made in this specification or the Standard Specifications to the cement specifications, e.g., SABS 471: Portland cement and rapid hardening Portland cement, it shall be replaced with the new specification:

SABS ENV 197-1: Cement-composition, specifications, and conformity criteria.

Part 1: Common cements.

Furthermore, where reference is made in this specification or the Standard Specifications to different cement types, the following new names shall be used as a guide but must be confirmed by the Employer's Agent.

Cement Grade	Cement Type	Approximate old product name	New Alpha	New Blue Circle	New NPC	New PPC	New Slagment
52.5	CEM I	Rapid hardening	Rapid Hard	Duracast	Eagle Super		-
42.5R	CEM I	Rapid hardening	-	-	-		-
42.5	CEM I	OPC*	Portland Cement	Duratech	-	OPC	-
	CEM I	LASRC	-	-	-	LASRC	-
	CEM II A-S	PC15SL	-	-	Eagle Plus	-	-
	CEM II B-S	RH30SL		-	Eagle Plus	-	-
32.5R	-	-	-	-	-	-	-
32.5	CEM II A-V	PC15FA	All – purpose cement	-	-	Surebuild	-
	CEM II A-W	PC15FA	-	-	-	Surebuild	-
	CEM II A-L	-	All purpose cement	-	-	Surebuild	-
	CEM II B-V OR W	PC25FA/PFAC**	-	Structcrete	-	Surecrete	-
	CEM II B-V OR W	PC25FA/PFAC**	-	Duracrete	-	Surecrete	-
	CEM III A	PBFC	-	BFC	Eagle Pro	-	PBFG
	CEM III A	RHSL	-	-	-	-	RHSL

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Cement Grade	Cement Type	Approximate old product name	New Alpha	New Blue Circle	New NPC	New PPC	New Slagment
22.5	MC 22.5X	PFAC***	Multi-purpose cement	Durabuild	-	-	-
	MC 22.5X	PFAC***	-	Buildcrete	-	-	-
12.5	MC 12.5	Walcrete	Mortar cement	Walcrete	-	Masonry	-
	MC 12.5	Mortacem	-	-	-	-	-

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 PRECAUTIONS (SUBCLAUSE 5.1)

Add the following to this Sub-clause:

"No stabilization shall be carried out during falling temperatures when the ambient air temperature falls below 7°C or during rising temperatures when the ambient air temperature is below 3°C.

The surface temperature of a compacted stabilized layer shall not be allowed to fall below 1°C during the first three (3) days after stabilization. The Contractor shall be responsible for taking the necessary measures in this connection, and especially to refrain from stabilizing when such temperatures become probable.

When a sudden unforeseen temperature drop to a level below this limit occurs, the stabilized layer shall be covered with the material required for the next layer to be constructed.

All stabilized layers damaged by frost or by the formation of ice in the layer shall be removed and replaced by the Contractor at his own expense.

The Contractor shall make allowance for these requirements in his construction programme, and no claims in this connection will be considered."

The Contractor shall at all times supply all workers exposed to chemical stabilizing agents with approved protective apparel, eyewear and masks, and no person without such apparel, eyewear and masks shall be permitted to work with or be exposed to the chemical agents. Precautionary measure shall also be taken to ensure that any livestock and the public will not be exposed to the chemical agents blown by the wind or under similar circumstances"

5.2 EXCAVATION (SUBCLAUSE 5.2)

5.2.1 Borrow pits (Subclause 5.2.2)

Insert the words "designated by the Employer's Agent and" *between the words* "pits" *and* "established" *in the first line.*

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[redacted]

5.3 PLACING AND COMPACTION (SUBCLAUSE 5.4)

5.3.1 Placing (Subclause 5.4.1)

The compacted thickness of the subbase for the various areas shall be that shown on the drawings.

5.3.2 Compaction (Subclause 5.4.4)

Notwithstanding the requirements of Clause 5.4.4.2 the subbase shall be compacted to 95% of modified AASHTO maximum density, as the case may be.

5.4 WEED KILLER (NEW SUBCLAUSE 5.8)

The subbase layer shall be treated before compaction by applying and mixing in an approved weed-killer in accordance with the manufacturer's instructions.

5.5 INSECTICIDE (NEW SUBCLAUSE 5.9)

An insecticide approved by the Employer's Agent shall be applied strictly in accordance with the manufacturer's instructions over the total area of the subbase. The instructions indicate whether the poison is to be applied before or after compaction of the layer.

6 TOLERANCES (CLAUSE 6)

6.1 STABILIZATION (SUBCLAUSE 6.3)

Add the following to the Subclause:

"The coefficient of variation shall not exceed 0,3 (30%) for mixing in place and 0,2 (20%) for plant mixed material, calculated as follows:

$$\frac{Sn}{Xn} \times 100$$

Where:

- Xn is the average and
- Sn is the standard deviation of stabilizing content per lot"

6.2 DIMENSTION AND LEVEL CONTROL (SUBCLAUSE 6.4)

The requirements of subclause 6.4 of SANS 1200M shall apply."

7 TESTING (CLAUSE 7)

7.1 STABILIZATION (SUBCLAUSE 7.3)

7.1.1 Strength tests for stabilized material (Subclause 7.3.3)

Amend the contents of this clause to read as follows:

"The Contractor shall carry out tests on the stabilized material at the frequency specified in 7.2.1 and 7.2.2 and check that the material complies with subclause 3.2.1 (d) and (e).

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8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

Insert a semicolon in the first line of paragraph (b) after the words "will be paid for once only" *and delete the rest of the paragraph.*

Add the following to Clause (d):

"A commercial source shall be held to include any off site sources or borrow pits located by the Contractor. Further that no additional payment will be made for the temporary stockpiling of material from commercial sources, class of excavation, method of processing (except stabilizing), or for overhaul."

"(e)* The requirements of subclause 8.2 of SANS 1200M shall apply. The Contractor shall further make provision in the rates tendered for the construction of the subbase, for the cost of his own process control testing and the cost of complying with subclause6.4."

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.2.1 Construct subbase using material from stockpile (Subclause 8.3.2)

Replace the heading and contents of Clause 8.3.2 with the following:

The rate tendered shall cover the cost of basic selection, loading from stockpiles, transporting, spreading, watering, compacting, final grading, complying with the tolerances, and testing.

No additional payment will be made for difficult work or hand operations in confined areas."

Replace the heading of Subclause 8.3.3 with the following:

8.2.2 Construct the subbase course/shoulders/gravel wearing course with material from commercial sources (Subclause 8.3.3)

Add the following paragraph to the end of this Subclause:

"This item shall also apply to the construction of subbase course/shoulders/gravel wearing course with material from borrow pits selected by the Contractor."

"No additional payment will be made for difficult work or hand operations in confined areas."

8.2.3 Extra over item 8.3.1 for class of excavation (Subclause 8.3.4)

Replace both "a) Intermediate excavation" *and the corresponding unit of measure with* "a) Not applicable (VOID)".

No extra-over payment will be made for excavation in material classified as intermediate excavation.

8.2.4 Screened-out material not used in the subbase (Subclause 8.3.7)

Remove the words "within the freehaul distance of 2 km" *from the last sentence of this Subclause.*

8.2.5 Overhaul (haul exceeding 2 km): (Subclause 8.3.9)

Delete this Subclause.

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No overhaul will be paid on material for the purposes of this Contract and all costs for transporting material must be included in the applicable tendered rates and amounts.

8.2.6 Treatment of subbase with: (New Subclause 8.3.11)

(a) Weed killer..... Unit: m2
(b) Insecticide..... Unit: m2

The tendered rates shall include full compensation for the supply, spreading and mixing-in or application of the poison.

Only areas that were treated on the written instructions of the Employer's Agent will be measured for payment.

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

3.1 PHYSICAL AND CHEMICAL PROPERTIES (SUBCLAUSE 3.3)

3.1.1 Natural gravel (stabilized or unstabilized) (Subclause 3.3.1)

Replace the contents of paragraph (a) with the following:

"(a) The maximum particle dimension of the gravel shall not exceed 63 mm."

3.1.2 Graded crushed stone (Subclause 3.3.2)

Add the following to Clause 3.3.2 after the words SANS 1083 ..... "for 37,5mm stone".

4 PLANT (CLAUSE 4)

No amendments

5 CONSTRUCTION (CLAUSE 5)

5.1 PLACEMENT AND COMPACTION OF A BASE OTHER THAN A WATER-BOUND MACADAM BASE (SUBCLAUSE 5.4)

5.1.1 Placing (Subclause 5.4.1)

Add the following:

"The compacted thickness of the base shall be as indicated on the drawings."

5.1.2 Compaction (Subclause 5.4.4)

Replace "98% of modified AASHTO maximum density" with "102% of modified AASHTO maximum dry density."

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6 TOLERANCES (CLAUSE 6)

6.1 DIMENSIONS, LEVELS, ETC. (Subclause 6.1)

6.1.1 Grade (Subclause 6.1.2)

Delete the contents of Subclauses (a) and (b) and replace with the following:

"The height of the edge of the channel above the top of the completed base is not less than the minimum thickness of asphalt surfacing, i.e., 5mm less than the specified thickness." (See subclause 6.3.4 of SANS 1200 MH)

6.1.2 Cross section (Subclause 6.1.5)

Replace "25mm" *in the second line of this Clause with* "10mm".

7 TESTING (CLAUSE 7)

7.1 ROUTINE INSPECTION AND TESTING (Subclause 7.3)

Replace table 4 with the following:

"

TABLE 4 - APPARENT DENSITY OF BASE

Specified apparent density %	Number of tests per lot	Minimum average density, %	Minimum value for any single test, %
86	4	86,1	82,7
	5	86,4	82,6
	6	86,5	82,4
	7	86,7	82,3
	8	86,8	82,2
	9	86,9	82,1

"

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8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.3)

8.1.1 Construct base with material from commercial sources or designated borrow areas (Subclause 8.3.3)

Replace the heading of Subclause 8.3.3 with the following:

"Construct base with material from commercial sources and compact to the specified modified AASHTO density"

Add the following:

"No additional payment will be made for difficult work or hand operations in confined areas."

8.1.2 Extra over 8.3.1 and 8.3.2, as applicable, for class of excavation (Subclause 8.3.4)

Replace both "a) Intermediate excavation" *and the corresponding unit of measure with* "a) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

8.1.3 Overhaul (Subclause 8.3.9)

Replace the contents of subclause 8.3.9 with the following:

"No overhaul will be paid on material for the purposes of this Contract and all the costs for transporting material must be included in the applicable tendered rates and amounts. "

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATIONS (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

3.1 PRIME (SUBCLAUSE 3.1)

Add the following to end of the Subclause:

"With reference to Clause 3.1 the prime to be used shall be Colprime E TM at 1.0ℓ/m².”

3.2 TACK COAT (SUBCLAUSE 3.3)

Add the following to the end of the Subclause:

"The tack coat to be used shall be a 30% anionic stable grade bituminous emulsion."

3.3 AGGREGATES (SUBCLAUSE 3.5)

3.3.1 General (Subclause 3.5.1)

Add the following to the end of the Subclause:

"The fine aggregate for the asphalt wearing course and asphalt base shall consist of crushed aggregate only. Natural sand shall not be permitted. Aggregates used in the approved production mix shall only be taken from stockpiles that are sufficient in size for the production of a minimum of three days' work and shall have been tested for conformance and uniformity. The test results shall be presented to the Employer's Agent. In cases where drum mixing is used the aggregate stockpiles shall be tested every second day or whenever new material is delivered. The test results must be presented to the Employer's Agent."

3.3.2 Bituminous binder absorption (Subclause 3.5.4)

Replace "shall be 1,0%" at the end of this Subclause with "shall not exceed 0,5% by mass."

Add the following to the end of the Subclause:

"When tested in accordance with TMH1 method C4 the bituminous binder absorption of the combined coarse and fine aggregate blend shall not exceed 0,5%"

3.3.3 Grading (SUBCLAUSE 3.5.6)

Add the following to the end of the first sentence:

"The tack coat to be used shall be a 30% anionic stable grade bituminous emulsion."

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3.4 MINERAL FILLER (SUBCLAUSE 3.6)

3.4.1 Base and continuously graded and gap-graded surfacing (Subclause 3.6.1)

Add the following to the end of the Subclause:

Notwithstanding this subclause, the mineral filler which, with the approval of the Employer's Agent, may be used to make up deficiencies in fines of the grading of the aggregate, shall be a powdered limestone or other suitable inert material approved by the Employer's Agent. All its particles shall pass a 0,600 mm sieve while not less than 65% by mass of the particles shall pass a 0,075 mm sieve.

3.4.2 Quality active mineral filler (Subclause 3.6.3)

Add the following to the end of the Subclause:

"Separate payment for active filler added on the instruction of the Employer's Agent, for the purposes of improving adhesion, shall only apply in respect of increases or decreases in the active filler content from that specified for the nominal mix for tender purposes.

The active filler for the asphalt base and surfacing layers for the nominal mix design for tender purposes shall be hydrated lime at a proportion of 1% by mass."

Add the following New Subclauses:

3.4.3 AGGREGATE FOR BLINDING (NEW SUBCLAUSE 3.7)

The aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6,7 mm sieve and not more than 10% passing the 2,36 mm sieve. The aggregate shall be clean, hard and free from excessive dust and flaking. It shall contain no clay, loam or other deleterious matter.

4 PLANT AND EQUIPMENT (CLAUSE 4)

4.1 BINDER DISTRIBUTOR (SUBCLAUSE 4.2)

Add the following to the end of the Subclause:

"The Employer's Agent may authorize the application of the prime or tack coat by means of a hand operated sprayer. Prior to allowing the latter the Contractor shall submit in writing for the Employer's Agent approval his intended method to ensure that the spray temperature and rate of application will meet the specified requirements. The continuation of this authority will be dependent upon satisfactory results being achieved."

5 CONSTRUCTION (CLAUSE 5)

5.1 GENERAL REQUIREMENTS (SUBCLAUSE 5.1)

5.1.1 Preparation of surface (SUBCLAUSE 5.1.1)

Add the following to subclause 5.1.1(a):

"The Contractor shall make every endeavour to protect the surface of a primed area and shall employ measures, such as the packing of stones across the area at regular intervals, to limit the passing of traffic over the primed surface. Where in the opinion of the Employer's Agent primed surface has become unsuitable for the direct placement of the asphalt, a tack coat at the rate ordered shall be applied."

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5.1.2 Weather limitations (Subclause 5.1.5)

Add the following to the end of the subclause 5.1.5.1:

"(d) When the moisture content of the upper 50mm of the base layer is greater than 50% of optimum moisture content."

5.1.3 Rates of applications and tolerance (Subclause 5.1.7)

Add the following to the end of the Subclause:

"The Colprime E TM shall be applied at a rate of 1.0ℓ/m².."

5.2 DESIGN OF ASPHALT (SUBCLAUSE 5.5)

5.2.1 General (Subclause 5.5.1)

Replace the contents of this Subclause with the following:

"The design of the asphalt mixes shall be in accordance with the design guidelines of TRH 8."

5.2.2 Marshall criteria (Subclause 5.5.2)

Delete this Subclause.

Add the following New Subclauses:

5.3 Blinding layer (New Subclause 5.11)

"When roads are constructed under traffic conditions, the prime shall be applied and allowed to penetrate for as long as is practicable before a blinding layer is applied at a rate of 0,0035 m3/m2. 'Caking' of the aggregate that may take place and cause problems during the surfacing process shall be removed before the final surfacing commences."

6 TOLERANCES (CLAUSE 6)

6.1 DIMENSIONS, LEVELS, ETC. (SUBCLAUSE 6.3)

6.1.1 Grade (Subclause 6.3.2)

Add the following to the end of the Subclause:

"Notwithstanding the stated tolerances, the grade shall be such that no ponding will occur."

6.1.2 Cross-Section (Subclause 6.3.5)

Add the following to the end of the Subclause:

"Notwithstanding the stated tolerances, at no point on the surfacing shall the level be below that of the adjacent low side concrete channel or edge strip."

6.1.3 Smoothness (New Subclause 6.3.7)

"Degree of accuracy 1 is applicable."

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7 TESTING (CLAUSE 7)

7.1 MIX DESIGN (SUBCLAUSE 7.1)

The requirements as stated shall be submitted to the Employer's Agent at least 1 week before the programmed date of the start of production.

7.2 CONTROL DURING CONSTRUCTION (SUBCLAUSE 7.2)

7.2.1 Density testing (Subclause 7.2.4)

Replace the second sentence of this Clause "Not more than ..... specified density." *with*:

"The density of all cores shall be equal to or greater than 96% of Rice density for the lot to be acceptable."

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 RATES OF APPLICATION AND BITUMINOUS BINDER CONTENT (SUBCLAUSE 8.1)

8.1.1 PRIME (SUBCLAUSE 8.1.2)

Add the following:

"The prime coat shall be Colprime E TM applied at a rate of 1,0 litre/m² for AE-2 binder"

8.1.2 TACK COAT (SUBCLAUSE 8.1.4)

Replace the contents of this Subclause with the following:

"The tack coat shall be a 30% spray grade emulsion applied at a rate of 0,55 litre/m²."

8.2 COMPUTATION OF QUANTITES (SUBCLAUSE 8.4)

Add the following to the end of Subclause 8.4.2:

"Notwithstanding the provisions of Clause 8.4.2, the unit of measurement for asphalt shall be the square metre of asphalt laid and compacted in accordance with the specifications."

8.3 SCHEDULED ITEMS (SUBCLAUSE 8.5)

8.3.1 Prime Coat (Subclause 8.5.1)

Add the following to the end of the Subclause:

"The rate tendered shall also provide for applying the prime using a hand operated sprayer, where required."

8.3.2 Tack Coat (Subclause 8.5.3)

Add the following to the end of the Subclause:

"The rate tendered shall also provide for applying the tack coat using a hand operated sprayer, where required."

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[redacted]

8.3.3 Asphalt (nominal thickness indicated) (SUBCLAUSE 8.5.4)

(Minimum thickness, type of asphalt and grade of bituminous binder specified)

Change the unit of measure of asphalt laid and compacted from "Unit: t" to "Unit: m^2".

The rate shall cover the cost of preparing an approved design mix, the supply of all materials as per stated minimum contents including filler, the mixing and manufacture of asphalt in accordance with the specifications and approved design mix, hauling, placing and compacting the asphalt, any additional operations, the supply of hand operated equipment and handwork for working in areas inaccessible to normal plant, as well as for process control testing, protecting and maintaining the work as specified."

Add the following new Subclauses:

8.3.4 Variations in active mineral filler content (New Subclause 8.5.9) ..... Unit: t

Separate items will be scheduled for each type of mineral filler to be used.

The rates shall cover the cost of the additional or reduced amount of filler to be used in terms of 8.2., and the rates will be added to or deducted from the rates applicable to 8.5.1 – 8.5.4 as appropriate.

8.3.5 Allowance for trial/testing (New Subclause 8.5.10) ..... Unit: m^2

The unit of measurement shall be the square metre.

This item will only be applicable where a trial section is ordered and is found to be acceptable but does not form part of the works measured under 8.5.4.

The rate shall cover all the costs enumerated in 8.5.4 together with the cost of obtaining approval and of disruption of the program.

8.3.6 Blinding Layer (New Subclause 8.5.11) ..... Unit: m^2

The unit of measurement shall be the square metre of prime coat blinded with aggregate as instructed by the Employer's Agent.

The tendered rate shall include full compensation for procuring, furnishing and applying the aggregate for blinding as directed by the Employer's Agent.

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1 SCOPE (CLAUSE 1)

No amendments.

2 INTERPRETATION (CLAUSE 2)

No amendments.

3 MATERIALS (CLAUSE 3)

3.1 Class, Strength and Type (Subclause 3.1.2)

Replace the heading and the contents of the subclause with the following:

" **Pavers**"

Pavers for use to the carriageway/sidewalk shall be as indicated on the relevant Landscape plan and meet the requirements as stated in Structural Design of segmented block pavements, UTG2.

The pavers shall comply with SANS 1058 (2012):
The 80 mm shall be Class 40 with a Tensile Splitting Strength of 2,6 MPa.

For control testing the Contractor shall provide test results, by an independent SANAS accredited laboratory, in accordance with Table 3 of SANS 1058.

As a minimum, the Contractor shall provide test results at 1 lot per 1000 m^2 of paving.

The cost of control testing shall be borne by the Contractor.

The Employers Agent may elect for additional check testing to be done. The Contractor shall be reimbursed for additional check testing which passes.

4 PLANT (CLAUSE 4)

No amendments.

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5 CONSTRUCTION (CLAUSE 5)

5.1 PREPARATION (SUBCLAUSE 5.1)

Notwithstanding the provisions of this Clause, the construction of the earthworks and controlled layers shall be completed in accordance with the applicable requirements of SABS 1200 DM and SABS 1200 ME, and any amendments thereto, as well as the details shown on the drawings.

5.2 EDGE RESTRAINTS (SUBCLAUSE 5.2)

Add the following to the end of this Subclause:

"Edge Restraints shall be constructed with expansion joints of width at least 12 mm at intervals not exceeding 10 m. These joints must be filled with a compound such as flexcell or similar approved product and sealed with a polysulphide sealant."

5.3 LAYING OF UNITS (SUBCLAUSE 5.4)

Notwithstanding the provisions of this Clause, filler units shall be cut such that they are close fitting. No chopping or breaking of the units will be permitted.

5.4 FILLING GAPS IN UNIT PATTERN (SUBCLAUSE 5.5)

Delete the contents of this Clause and replace them with the following:

"Clause 5.4 shall apply."

5.5 COMPACTION OF UNITS (SUBCLAUSE 5.6)

Insert in Subclause 5.6.1, after the first sentence, the following:

"A suitable vibrating-plate compactor operating at a frequency of 65 Hz to 100 Hz and a low amplitude shall be used. Its plate surface shall be 0,2 m^2 to 0,4 m^2 and it shall develop a centrifugal force of 7 kN to 16 kN."

5.6 JOINT FILLING (SUBCLAUSE 5.7)

Replace the last two paragraphs of this Subclause with the following:

"A mixture of sand that complies with 3.3(b) and cement (Ratio 5:1) shall be brushed into the joints until they are full, and sufficient passes of a plate compactor shall be made to settle the joint filling.

The procedure shall be repeated until the joints remain full after compaction.

All excess shall be washed off and care shall be taken not to contaminate the stormwater system. Damage caused during compaction shall be made good by the Contractor at his own expense."

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6 TOLERANCES (CLAUSE 6)

No amendments.

7 TESTING (CLAUSE 7)

No amendments.

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.1.1 Provision of edge restraints (Subclause 8.2.1)

Add the following to the end of this Subclause:

"The rates shall cover all the costs for excavating, bedding, laying (including expansion joints), jointing, compacting and backfilling, including the removal of excess material."

8.1.2 Construction of paving complete (Subclause 8.2.2)

Add the following to the end of this Subclause:

"The tendered rate shall also include full compensation for cutting units to fit edge restraints, for waste and the removal thereof from the Site, and delays and disruptions to the programme."

8.1.3 Cutting units to fit edge restraints (Subclause 8.2.3)

Delete the contents of this clause and replace with the following:

"Cutting units to fit edge restraints will not be measured separately but be included for in the rate for 8.2.2."

"The cutting of units to suit radii > 1,0m shall be classified as straight cutting."

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1 SCOPE (CLAUSE 1)

Add the following definitions:

"This specification shall also cover the construction of concrete lined channels."

2 INTERPRETATIONS (CLAUSE 2)

2.1 DEFINITIONS (SUBCLAUSE 2.3)

Add the following definitions:

"Backing The supporting concrete behind the edge of the precast kerb, as shown on the drawings.

Bedding material The material on which precast kerbs and channels are bedded shall consist of crushed stone, cinders, slug, sand or other approved porous material having a maximum particle size of 13,2mm. Commonly referred to and shown on the drawings, kerb and channel details."

3 MATERIALS (CLAUSE 3)

3.1 CONCRETE (SUBCLAUSE 3.1)

Add the following to the end of this Subclause:

"The Contractor shall timeously submit the concrete mix design for cast-in-situ kerbing to the Employer's Agent for approval and no kerbing shall be placed before the mix design has been approved."

3.2 PRECAST KERBING AND CHANNELLING (SUBCLAUSE 3.2)

3.2.1 General (Subclause 3.2.1)

Add the following to the end of this Subclause:

"The profile/dimensions of precast kerbs and channels must be in accordance with the details shown on the drawing."

3.2.2 Curved Kerbing (Subclause 3.2.2)

In the heading, replace the word "Kerbing" with:

" Kerbing and Channelling".

Replace the references to "kerbing" throughout this Subclause with:

"kerbing and channelling".

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3.3 CONCRETE FOR EXTRUDED IN-SITU KERBING AND CHANNELLING (SUBCLAUSE 3.7)

3.3.1 Concrete (Subclause 3.7.2)

Notwithstanding the requirements of this Clause, the Contractor shall take note that the acceptability of extruded kerbing and channelling will be evaluated on the basis of the compressive strengths of cores taken. The Contractor shall therefore at his own discretion increase the grade of concrete used.

3.4 CURING COMPOUND (SUBCLAUSE 3.8)

Notwithstanding the provisions of this Clause, the requirements of subclause 5.5.8 of SANS 1200G shall apply.

3.5 BEDDING MATERIAL (SUBCLAUSE 3.9)

Replace the contents of this Subclause with the following:

"The concrete on which the kerbing and channelling will be placed must be of the strength and thickness specified in the drawings. Where no details are provided on the drawings, the material shall consist of crushed stone, cinders, slag, sand, or other approved porous material having a maximum particle size of 13.2mm."

3.6 CONCRETE FOR EDGING STRIPS (NEW SUBCLAUSE 3.10)

The requirements of Clause 3.7 and 3.7.2 shall apply to concrete for edging strips."

4 PLANT (CLAUSE 4)

No amendments.

5 CONSTRUCTION (CLAUSE 5)

5.1 EXCAVATION AND BEDDING (SUBCLAUSE 5.1)

Delete the first paragraph viz. "Trenches for ..... grade."

Notwithstanding the provisions of this Subclause, open drains outside the bounds of road reserves shall be trimmed to the lines and levels given on the drawings or ordered and the surface area of the drain compacted to 90% of modified AASHTO maximum density. The compacted depth shall be 150mm. Where in the opinion of the Employer's Agent the in-situ material is unsuitable, the Employer's Agent may order that it be removed to the depth required and replaced with selected material compacted to a density of at least 90% of modified AASHTO maximum density, or 15MPa/20 concrete.

Replace all instances of "90%" with:

"93% (100% for sand)

Add the following to the end of the Subclause:

"Excavations for road side channels shall be trimmed to the lines and levels given on the drawings or ordered, so as to permit the accurate construction of the concrete linings, and the surface area of the channels compacted to 90% of modified AASHTO maximum density. The compacted depth shall be 150mm. Where in the opinion of the Employer's Agent the in-situ material is unsuitable, the Employer's

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Agent may order it to be removed to the depth required and replaced with selected material compacted to a density of at least 90% of modified AASHTO maximum density, or 15MPa/19 concrete.

The excavations for channel cross drains shall be completed in accordance with the requirements stated in the paragraph immediately above, except that provision shall be made for the accommodation of the selected layer detailed on the drawings."

5.2 PRECAST CONCRETE KERBING AND CHANNELING (SUBCLAUSE 5.2)

Replace the first sentence with:

"Kerbing and Channelling of precast concrete must be placed on a concrete bedding as required in subclause 3.9."

Replace "50mm" *in the second line with* "10mm minimum". For bedding more than 30mm thick, the requirements of subclause 3.9 shall apply.

Delete in the last paragraph from "the kerbs shall" *to* "15 MPa and replace with Class 20MPa/13mm."

Add the following new subclauses:

5.2.1 PRECAST CONCRETE KERBING AND CHANNELING (NEW SUBCLAUSE 5.2.1)

After the precast kerbs have been laid the formwork for the channelling shall be set up. Expansion joints shall be allowed for at approximately 8 metres intervals, i.e. opposite the joint between the kerbs. The principles of Clause 5.4 shall apply to the construction of cast-in-situ channelling.

5.3 MACHINE-LAID CAST IN-SITU (EXTRUDED) KERBING AND CHANNELLING (NEW SUBCLAUSE 5.8)

Add to the bottom of the heading the following:

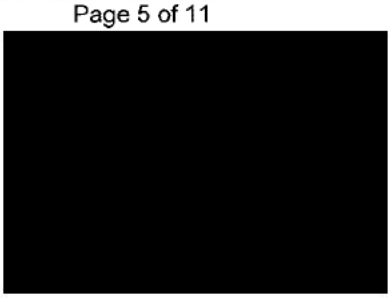
Before commencing kerb laying on the site, the first 50m length of kerb and channel to be constructed shall be regarded as trial kerb and channel. The Contractor shall demonstrate in the trial length the methods he proposes to use for the construction of the kerb and channel, including joints, texturing, the achievement of a smooth surface and dense fully compacted concrete. It may be constructed either in the recognised position in a road or elsewhere on the site in which case it shall be demolished, broken out and removed at the Contractor's expense.

The trial kerb and channel shall be constructed with the plant and equipment to be used on the works and the equipment's motion forwards and the handwork carried out on the extruded section shall be so controlled and used as to produce a kerb and channel to the shape, lines and levels specified.

The time taken to lay the test strip shall be recorded, which in the event of acceptance, shall be used to calculate a rate of extrusion which shall not be exceeded without the permission of the Employer's Agent.

If the concrete in the trial strip fails to meet the test requirements, the Contractor may, at his own cost, cut further cores from the kerb and or channel up to a maximum of one core per 100m length. The strengths obtained on such cores, together with those tested on the instruction of the Employer's Agent, shall be used to test compliance with the strength requirements.

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The Contractor may, unless advised of any deficiencies in the trial kerb and channel, proceed with kerbing as soon as acceptable core test results are obtained.

In the event of deficiencies in the trial kerb and channel, the Contractor shall, at his own expense, demolish the rejected sections and remove to the designated tip site and repeat the 50m long trial strip. This process shall be continued until the Contractor has produced kerb and channel in accordance with this specification. He may then proceed with kerb and channel construction proper. Any unacceptable trial length shall be broken out and removed to spoil, at the Contractor's expense before any subsequent trail length is permitted to commence.

Core test holes shall be filled with 30 MPa concrete mixed with a suitable adhesive compound.

No other means of testing the concrete will be considered and any kerb or channel not complying with all the requirements of the specification shall be broken out, removed to spoil and replaced at the Contractor's own expense.

The Contractor shall ensure that no change of circumstances or conditions is made to jeopardise the quality of the kerb and channel under construction. If, in the opinion of the Employer's Agent, this does occur, he may order the construction of a further trial length of 50m of kerb and channel in accordance with the requirements of this specification. Work on the kerb and channel proper shall not proceed until a trial strip has been constructed in accordance with the requirements of this specification. No claims for delays will be considered by the Employer's Agent on account of further trial lengths of kerbing being ordered.

5.3.1 Subbase preparation (Subclause 5.8.3)

Delete in the first line from: "500mm beyond" to "as relevant" *and replace by* "150mm beyond the back face of the kerb". Note this dimension applies to the compaction width required for the road layer.

Notwithstanding the provisions of this Clause, where kerbing and channelling is to be constructed along existing travelled ways, the material at the founding level shall be trimmed to the required line and level and compacted to give a firm surface.

5.3.2 Curing (5.8.5)

Notwithstanding the provisions of this Clause, curing shall be carried out in accordance with the requirements of subclause 5.5.8 of SANS 1200G.

5.4 TRANSITION SECTIONS AND INLET AND OUTLET STRUCTURES (SUBCLAUSE 5.11)

Delete the words "and with the requirements of the Specification" *in the second paragraph.*

5.5 EXISTING KERBING (NEW SUBCLAUSE 5.13)

The kerbs to be removed shall be inspected by the Employer's Agent in the presence of the contractor prior to their removal to determine the number of kerbs suitable for re-use.

The contractor is advised to use the greatest care when removing those kerbs earmarked for re-use, for should the kerbs be damaged and be subsequently rejected, he shall replace them with new kerbs at his own cost.

5.6 WATERTESTING OF KERBS (NEW SUBCLAUSE 5.14)

After the kerbs, channels inlets etc. have been constructed the kerbs, channels, etc must be cleaned and tested with water to ensure that no water is standing in any channel. This test must be done after the base

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has been completed but before the placing of the surface seal. Any adjustments to kerbs, channels etc must be completed before the surface seal is applied.

5.7 EXPANSION JOINTS (NEW SUBCLAUSE 5.15)

These joints shall be provided at 10 m intervals, through the kerb, channels, and edging strips. These joints shall be 12 mm wide, filled with a compound such as flexcell or similar product and sealed with a polysulphide sealant. Costs of furnishing the materials and construction of the joint are deemed to be included in the laying rate.

5.8 EDGING STRIPS (NEW SUBCLAUSE 5.16)

Edging strips shall be constructed in accordance with the details shown on the drawings and the applicable requirements of Clauses 5.2 through to 5.10.

The edging strips shall be cast in alternate sections approximately 2m in length and the construction joints so formed shall coincide with joints in the precast kerbing, except that an expansion joint in lieu of a construction joint shall be provided at approximately 8m intervals. Where applicable, expansion joints in the channelling shall coincide with those in the precast kerbing.

5.9 CONCRETE LINING FOR ROAD SIDE CHANNELS AND CHANNEL CROSS DRAINS (NEW SUBCLAUSE 5.17)

Concrete lining for road side channels and channel cross drains shall be constructed as detailed on the drawings and in accordance with the requirements of Subclause 5.6.

Curing shall be carried out as specified in subclause5.5.8 of SANS 1200G."

6 TOLERANCES (CLAUSE 6)

6.1 CONCRETE KERBING AND CHANNELLING (SUBCLAUSE 6.1)

Delete in Subclause (b) (1) the allowance of "0, - 10" and replace by the following:
"± 10".

And to item b (1) wording:

"provided the base layer thicknesses are not prejudiced and no adverse grade results."

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6.2 CONCRETE LINED CHANNELS AND CONCRETE CHUTES (SUBCLAUSE 6.2)

Add the following:

"The requirements of this clause shall also as relevant apply to concrete lined road side channels and channel cross drains.

With respect to unlined open drains outside road reserves the following shall apply:

	ITEM	PERMISSIBLE DEVIATION
(a)	Horizontal alignment Deviation from the specified position of each edge or the centreline	±150mm
(b)	Vertical alignment Deviation from designated depth, subject to there being no adverse grade	± 50mm
(c)	Trueness of exposed surfaces Surface irregularities on each exposed surface when tested with a 3m straight edge	± 15mm
(d)	Cross-sectional dimensions Deviation from specified side slopes	± 10%

7 TESTING (CLAUSE 7)

7.1 CAST-IN-SITU AND EXTRUDED KERBING AND CHANNELLING (SUBCLAUSE 7.2)

Delete subclauses 7.2.1 and 7.2.2 and replace with the following:

"7.2.1 Tests. The Contractor shall carry out a minimum of three cube crushing tests per 300 m of kerbing placed. The cost of such tests shall be deemed included in the rates tendered for kerbing.
One cube crushing test shall consist of a set of six cubes made with concrete taken from the mixer, the kerbing machine or from any part of the work as ordered.

If, after 28 days in an approved laboratory, after three cubes of any set of six cubes have been tested, the average crushing strength is found to be more than 3 MPa below the specified strength, the kerbing represented by the cubes will be rejected. The numerical value of the compressive strength of the core used for adjudication shall be that value determined in accordance with Clause 6.3 of SANS Method 865.

The Contractor may apply for resubmission of the rejected section based on cores drilled from this section and tested for the estimated actual crushing strength in accordance with SANS method 865 (excluding Appendix A).

The cost of drilling and testing the cores is for the Contractor's account, regardless of the outcome of the tests on the cores. The number of cores required will be determined by the Employer's Agent and the criterion for rejection or acceptance of the section represented by the cores shall be as specified above for cubes."

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7.2 RESPONSIBILITY FOR THE COST OF TESTING (SUBCLAUSE 7.3)

Delete this subclause

8 MEASUREMENT AND PAYMENT (CLAUSE 8)

8.1 BASIC PRINCIPLES (SUBCLAUSE 8.1)

The rate for precast concrete kerbing shall include for the concrete bedding and backing as shown on the drawings.

8.2 SCHEDULED ITEMS (SUBCLAUSE 8.2)

8.2.1 Concrete kerbing (Subclause 8.2.1)

In the heading, replace the word "Kerbing" with " Concrete Kerbing".

Add after "and for bedding" *in the second line of clause (b) with* "irrespective of variations to the thickness of the bedding".

Replace "7.2" *in the second line of Clause (b) with* "7.1".

Add at the end of Clause (b) "as well as for the installation of expansion joints, as detailed on the drawings, and the supply and placing of class 20/13 continuous backing, irrespective of variations to the thickness of the backing".

Replace "5.8.2" in the third line of paragraph (e) with "5.8.3".

Replace "1000m" in the second last line of Clause (e) with "600m"

Delete the following in the second last line of Clause (e):

"and as specified in clause 7.2"

Replace the word "kerbing" throughout this subclause with "Concrete Kerbing".

8.2.2 Concrete kerbing and channelling combined (Subclause 8.2.2)

Add: "Acceptance of work that is substandard in measured compressive strength shall be subject to reduced payment at the following percentages of the tendered rate for the item.

Measured compressive strength of individual core	**% of full payment**
15 MPa up to 20 MPa	20
Less than 15 MPa	Nil"

8.2.3 Variations of tests on extruded kerbing (Subclause 8.2.3)

(a) Core strength tests.....Unit: No
(b) Set of three cores.....Unit: No

The rate tendered shall cover the cost of preparing a test specimen, despatching to an approved laboratory, testing and making good.

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A test, the results of which show that the kerbing fails to comply with the requirements of the specification will irrespective of whether the kerbing is accepted for payment in terms of subclause 8.2.2, not be measured for payment.
Note:

The Employer's Agent reserves the right to arrange for testing if the Contractor fails to expeditiously do so, or to undertake all testing, in which case the rates tendered shall not apply. If the coring and testing is carried out via the local Road Laboratory the Contractor will be debited with the cost of the test when the measured compressive strength is less than 20 MPa."

8.2.4 Ancillaries (Subclause 8.2.6)

In Subclause 8.2.6.2, replace both "2) Extra-over for intermediate material" *and the corresponding unit of measure with* "2) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

Replace the heading and contents of subclause 8.2.7 with the following:

8.2.5 Trimming and compaction to 90% of modified AASHTO maximum density of surface area of unlined open drains and areas to be concrete lined in (Subclause 8.2.7)

(a) Soft material ..... Unit: m^2
(b) Hard material ..... Unit: m^2

The unit of measurement shall be the area of the surface trimmed and compacted. The rate tendered shall cover the cost of all labour (including hand operations), plant and other incidentals necessary to trim and compact the areas to the standard specified.

No extra payment will be made in respect of any soil or gravel backfilling, additional concrete or mass concrete backfilling required because of overbreak or unavoidable unevenness of excavations in difficult ground. The cost thereof shall be deemed to be covered by the rates tendered.

All excavation, including the removal of unsuitable material where ordered and backfilling using selected material or concrete, will be measured for payment under the appropriate subclauses of SANS 1200D, SANS and 1200DM"

Replace the heading and contents of subclause 8.2.8 with the following:

8.2.6 20MPa/19mm Concrete lining to (Subclause 8.2.8) ..... Unit : m^2

The unit of measurement shall be the area of the surface to be concrete lined, irrespective of shape, cross-sectional slope or longitudinal grade.

The rate tendered shall cover the cost of all labour, plant, materials and incidentals required to construct the lining complete as detailed in the positions and to the extent shown on the drawings, or directed on site, including sprayed bitumen emulsion primer or polyethylene sheeting, formwork, mesh reinforcement, bitumen painted joints (expansion joints measured elsewhere) and finishing, as well as in the case of stormwater outlets, the building in of concrete pipe culverts.

Further, notwithstanding the requirements of subclause 7.2.2, work that is substandard in measured compressive strength may be accepted, subject to the Contractor accepting reduced payment at the following percentages of the tendered rate:

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Measured compressive strength of individual core	**Percentage of full payment**
15MPa up to 20MPa	50
Less that 15MPa	Nil"

Delete subclause 8.2.9.

Replace the heading of subclause 8.2.10 with the following:

8.2.7 Sealed joints in concrete lining of open drains (type or description stated) (Subclause 8.2.10).....Unit : m

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1. SCOPE (CLAUSE 1)

No Amendments.

2. INTERPRETATIONS (CLAUSE 2)

No Amendments.

3. MATERIALS (CLAUSE 3)

3.1 ROAD SIGNS (SUBCLAUSE 3.2)

3.1.1 General (Subclause 3.2.1)

*Replace "*South African*" in the first sentence with the following:*

"SADC" *in the first sentence.*

*Replace "*Council for Scientific and Industrial Research*" in footnote 1 with the following:*

"Government Printer".

3.1.2 Structural steel (Subclause 3.2.2)

Delete the words "except that they shall be of D-shape cross-section" *in the first paragraph.*

Add the following:

"All steel sign supports shall be hot-dip zinc-coated (galvanized) in accordance with SANS 763 for type A1 or B2 articles, as may be applicable."

3.1.3 Steel plate (Subclause 3.2.4)

Replace the entire contents of this Clause with the following:

"Steel plate for road signs shall be 1,4mm thick pre-painted galvanised steel plate (Iscor grade G275 Chromadek), which has been treated on both sides with an epoxy primer followed by a silicon polyester top coat. The total dry thickness of the treatment shall be at least 25µm."

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3.1.4 Paints and protective coatings (Subclause 3.2.8)

Replace the contents of Subclause 3.2.8.1 with the following:

"The sign supports and the backs of all road sign faces shall be painted grey. The colour code of the paint shall be code No D36 according to the CKS 279 classification. All surface damage to galvanising shall be made good with a proprietary galvanising product.

Newly galvanized surfaces shall be thoroughly scrubbed down with an approved galvanized iron cleaner to remove all traces of the resinous protective coating. The surface shall be washed down and scrubbed to remove all traces of grease, oil, dirt, etc. Two coats of calcium plumbate primer shall be applied to a dry film thickness of not less than 0,028 mm. The undercoat shall follow within one week of the primer."

3.1.5 Retro-reflective Material (Subclause 3.2.9)

In paragraph 3.2.9 (a) replace "CKS191" with:

"Class 1 in accordance with SANS 1519-1".

Delete paragraph 3.2.9(b) and replace with the following:

"High intensity grade complying with Class III in accordance with SANS 1519-1".

3.2 ROAD MARKING MATERIALS (SUBCLAUSE 3.3)

3.2.1 Non-reflectorised paint (Subclause 3.3.1.1)

Replace "SANS 731" with the following:

"SANS 731-1 : 1995"

Add the following to the end of the Subclause:

"The paint shall be Type 1, 2 or 3 and shall be of a drying classification Class 1 in accordance with SANS 731-1". The paint shall be Plascon Hysheen Road and Runway Marking Paint Products TP24, 41 or 88 or similar approved. The possible use of Plascon Hysheen Aquafest Road Marking Paint WTP1 as the final application on-site shall be considered at the end of the Defects Liability Period".

3.2.2 Reflectorised paint (Subclause 3.3.1.2)

Replace this subclause with the following:

"Reflectorised paint shall comply with the requirements of subclause 3.3.1.2 as well as the retro-reflectivity requirements set in SANS 731-1 paragraph 4, 17.3 for new markings."

4. PLANT (CLAUSE 4)

No Amendments.

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5. CONSTRUCTION (CLAUSE 5)

5.1 ROAD SIGNS (SUBCLAUSE 5.2)

5.1.1 Backing plates and boards (Subclause 5.2.1.2)

Add in the first sentence after "drawings" *the following:*

"and SADC Road traffic signs manual, Volume 4 to comply with the National Road Traffic Regulations, 2000."

5.1.2 Painting of road signs (Subclause 5.2.2.5)

Delete the entire Clause and replace with the following:

"Road sign boards shall be manufactured by a recognised manufacturer of road signs.

Retro reflective material shall be affixed to the road sign board face in strict accordance with the requirements and specifications of the retro reflective sheeting manufacturer. No silk screening of road sign faces shall be acceptable other than the screening of black symbols on Regulatory or warning signs."

5.2 ROAD MARKINGS (SUBCLAUSE 5.3)

5.2.1 Surface preparation (Subclause 5.3.2)

Insert the following before the last sentence:

"The areas where new markings shall be painted shall be thoroughly cleaned by acid pickling with a diluted product like Aquasolv Degreaser or similar, scrubbing with a steel brush and rinsing it with fresh water. All run-off shall be intercepted and treated prior to wasting into a stormwater system. No paint shall be applied on wet or untreated concrete surfaces. The need to apply a primer prior to the application of the paint shall be assessed before the final markings are applied."

Add the following to the end of the Subclause:

"At the end of the Defects Liability Period the markings shall be repainted on cleaned and degreased surfaces in accordance with the paint manufacturer's specifications."

5.2.2 Setting out of road markings (Subclause 5.3.3)

In the second paragraph, replace "Road Traffic Ordinance", *and* "South African" with the following:

"National Road Traffic Regulations, 2000" and "SADC" respectively.

6. TOLERANCES (CLAUSE 6)

No Amendments.

7. TESTING (CLAUSE 7)

No Amendments.

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8. MEASUREMENT AND PAYMENTS (CLAUSE 8)

Replace all "km" units with "km or m"

8.1 ROAD MARKINGS (SUBCLAUSE 8.4.1)

Replace the heading and amend the contents of Subclause 8.4.1 as follows:

8.1.1 Reflectorized road marking paint applied at nominal rate of 0,42ℓ/m², as scheduled (SUBCLAUSE 8.4.1)

Notwithstanding the requirements of Subclause 8.4.1 painted road lines will be measured by net length and special markings by number.

The rates shall cover the cost of supplying all materials and equipment necessary and for painting and reflectorizing, protection, setting out, premarking of the road markings and remarking at the end of the defects liability period.

Note:
The Contractor shall note that the various materials have been scheduled in the Bill of Quantities. The payment provisions as specified shall none the less apply as appropriate."

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[redacted]

3.7.3 PROCESS DESCRIPTION

The Process Description is included immediately hereafter, comprising 14 pages.



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2. PROCESS WATER COOLER

2.1 OVERVIEW

Process water required for the generation of the sodium hypochlorite solution will be pumped from the reservoir via the service water pumps to the sodium hypochlorite generation building. The process water line will feed two safety showers, a hose connection point, the administration building and will also feed a process water cooler consisting of a plate & frame heat exchanger and chiller.

The sodium hypochlorite generation process requires process water within a temperature range of 12.7–26.7 °C. Based on the site location in Muldersvlei, and the fact that the process water will be sourced from the large reservoir on site, it is envisaged that the process water may require cooling during the hottest 2–3 months of the year. It is deemed very improbable that the temperature of the incoming process water will be less than the minimum required temperature of 12.7 °C, therefore for this reason provision has not been made to include a process water heater in this design.

2.2 PLATE HEAT EXCHANGER

Process water entering the sodium hypochlorite generation process will first pass through a plate heat exchanger. This plate heat exchanger shall be sized for a process water flow rate of 2464 L/hr with a counter current chilled water flow rate of 4928 L/hr. The plate heat exchanger shall provide sufficient heat transfer area to allow the process water to be cooled from 26 °C to 16 °C, with the counterflow chilled water warming from 11 °C to 16 °C between inflow and outflow respectively.

A bypass line around the plate heat exchanger, with manual isolation valves, will allow for the heat exchanger to be isolated for maintenance purposes. It is not deemed necessary to include a standby heat exchanger in this design as this unit will require minimal maintenance and it is anticipated that it will only be fully operational for 2–3 months of the year, allowing for maintenance to be undertaken during the remaining 9–10 months of the year when the unit is not operational.

The plate heat exchanger is captured in P&ID 1001757-2000-PID-PP-2050.

2.3 CHILLER

A water chiller will feed the plate heat exchanger with chilled water in a counterflow regime. This water chiller will connect, via PLC, to a flow switch and temperature transmitter installed on the process water stream upstream of the heat exchanger. This will allow for the chiller to only operate when there is simultaneously flow in the process water stream and when the temperature of this process water is above 26 °C. If any of these two conditions is not met, the chiller will not operate, and the process water will flow through the heat exchanger without any heat transfer to chilled water.

Isolation valves will be installed on the chilled water circuit to allow the water chiller to be isolated for maintenance purposes. It is not deemed necessary to include a standby chiller in the design as the chiller will require minimal maintenance and will only be operational for 2–3 months of the year, allowing for maintenance to be conducted during the remaining 9–10 months of the year when the unit is not operational.

The chiller is captured in P&ID 1001757-2000-PID-PP-2050.

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1. INTRODUCTION

This section provides a brief overview on the process. The overall process is captured by the following process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs) which should be read in conjunction with this section:

- 1001757-2000-PFD-PP-2000 PFD: On-site sodium hypochlorite generation
- 1001757-2000-PFD-PP-2001 PFD: Sodium hypochlorite dosing pumps and equipment
- 1001757-2000-PFD-PP-2002 PFD: Commercial sodium hypochlorite dilution
- 1001757-2000-PFD-PP-2003 PFD: Calcium hypochlorite preparation equipment
- 1001757-2000-PFD-PP-2004 PFD: Reservoir and pipelines
- 1001757-2000-PID-PP-2050 P&ID: Salt dissolution tanks
- 1001757-2000-PID-PP-2051 P&ID: Sodium hypochlorite generator 1
- 1001757-2000-PID-PP-2052 P&ID: Sodium hypochlorite generator 2
- 1001757-2000-PID-PP-2053 P&ID: Sodium hypochlorite generator 3
- 1001757-2000-PID-PP-2054 P&ID: Sodium hypochlorite generator 4
- 1001757-2000-PID-PP-2055 P&ID: Sodium hypo storage tanks
- 1001757-2000-PID-PP-2056 P&ID: Sodium hypochlorite dosing pumps
- 1001757-2000-PID-PP-2057 P&ID: Commercial sodium hypochlorite dilution
- 1001757-2000-PID-PP-2058 P&ID: Calcium hypochlorite make-up
- 1001757-2000-PID-PP-2059 P&ID: Calcium hypochlorite dosing pumps
- 1001757-2000-PID-PP-2060 P&ID: Service water wet well
- 1001757-2000-PID-PP-2061 P&ID: Service water pumps
- 1001757-2000-PID-PP-2062 P&ID: 300 ML reservoir and bulk pipelines
- 1001757-2000-PID-PP-2063 P&ID: Remote valve chambers and bulk pipelines

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3. SALT DISSOLUTION TANKS

3.1 OVERVIEW

Two salt dissolution tanks (1 duty, 1 standby) shall allow for a saturated salt solution to be produced on site to feed the electrolytic reactor. These tanks will be fed via a common header with softened water produced by the onboard water softeners on the four sodium hypochlorite generators. The saturated brine solution produced in the salt tanks will feed a common header before splitting to feed the electrolytic reactors of the four sodium hypochlorite generators via an onboard dosing pump.

3.2 SALT DISSOLUTION TANK

The concrete salt dissolution tanks are sized large enough to allow placement of a 1-ton bag of sodium chloride salt via an overhead travelling crane inside the tank. Two salt dissolution tanks have been provided which will include a removable top-cover to allow the tank to remain covered until the salt bag is replenished.

The salt dissolution tanks are captured in P&ID 1001757-2000-PID-PP-2050.

3.3 SALT TANK LEVEL CONTROL

Each salt dissolution tank will be fitted with four level switches. One level switch will provide a low-low-level alarm while the other switch provides a high-high-level alarm. The remaining level switches will provide low-level and high-level control points to maintain the water level in the tank by opening and closing the softened water supply valve. The valve used for the softened water supply will be an actuated valve to allow for automatic filling of the tank. Actuated valves will also be used for isolation on the discharge of each tank.

The level control systems for the salt dissolution tanks are captured in P&ID 1001757-2000-PID-PP-2050.

3.4 SALT LEVEL MONITOR

Each salt dissolution tank will also be fitted with a radar salt level monitor to alert the operator when the salt level is low to ensure that the salt level of the saturated brine solution in the tank is maintained. The salt level monitor will be installed on a movable arm to minimise obstruction when the salt level is being replenished in the tank via the addition of a sodium chloride bag.

The salt level monitors for the salt dissolution tanks are captured in P&ID 1001757-2000-PID-PP-2050.

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4. SODIUM HYPOCHLORITE GENERATORS

4.1 OVERVIEW

The sodium hypochlorite generation process will include four sodium hypochlorite generators (2 duty, 2 standby). Each of these generators will be skid-mounted units including an onboard water softener and an onboard electrolytic reactor. Each unit will include two inlet streams (for process water and brine) and two outlet streams (for softened water and sodium hypochlorite solution).

A mobile HCl cleaning system is included in the design, and this will allow for each of the skid mounted units to be cleaned by an operator to remove the build-up of contaminants over time.

4.2 WATER SOFTENER

Each sodium hypochlorite generator is equipped with an onboard water softener that will be fed with service water from a common header after the water has passed through a heat exchanger. The water softeners will contain a cationic resin which will absorb calcium and magnesium ions from the water and exchange them with sodium ions via the ion exchange process.

When the resin is close to complete saturation, it will be regenerated using brine from the salt dissolution tanks with the back-wash water fed to the drain. Each regeneration process will consume approximately 23 L of brine and 380 L of back-wash water.

The outlet stream from the water softener will feed to two process units: the salt dissolution tanks and the onboard electrolytic reactors.

The onboard water softeners are captured in P&IDs 1001757-2000-PID-PP-2051, 1001757-2000-PID-PP-2052, 1001757-2000-PID-PP-2053 and 1001757-2000-PID-PP-2054.

4.3 ELECTROLYTIC REACTOR

The electrolytic reactor will be fed by a mixture of two streams: the saturated brine stream from the salt dissolution tanks, and softened water from the onboard water softener. Brine from the salt dissolution tanks will be fed to each of the sodium hypochlorite generator skids via an onboard pump on the sodium hypochlorite generator to a mixing manifold where it will be blended with softened water. Onboard control valves, rotameters and flow meters will be installed on the softened water and brine streams such that the optimum dilution ratio can be achieved between these two streams before entering the electrolytic reactor.

Inside the electrolytic reactor, the diluted sodium chloride solution will be converted to sodium hypochlorite in the bipolar electrolysis chambers. This electrolysis process will generate chlorine gas (Cl_2) at the anode, and sodium (Na) at the cathode. Once formed, the sodium will immediately react with the water to produce sodium hydroxide (NaOH, caustic soda) and hydrogen gas (H_2). The sodium hydroxide will then react with the chlorine gas to produce sodium hypochlorite (NaOCl), sodium chloride (NaCl) and water (H_2O). The hydrogen gas produced will be present in the gaseous form in the sodium hypochlorite solution.

The 0.8% sodium hypochlorite solution produced in each of the electrolytic reactors will then be fed, via a common header, to the sodium hypochlorite storage tanks.

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The onboard electrolytic reactors are captured in P&IDs 1001757-2000-PID-PP-2051, 1001757-2000-PID-PP-2052, 1001757-2000-PID-PP-2053 and 1001757-2000-PID-PP-2054.

4.4 MOBILE HCL CLEANING SYSTEM

A mobile cleaning system will allow for the electrodes in the electrolytic reactors to be cleaned without the need to dismantle the skid-mounted system. This mobile cleaning system will consist of a 60 L canister holding a 5% hydrochloric acid (HCl) solution, a circulation pump, a pressure line with ball valve and connection parts, and a return line with ball valve and connecting parts. The mobile cleaning system will be housed on a hand truck to allow for an operator to transport it to any of the sodium hypochlorite generators that require cleaning.

The HCl cleaning solution will assist in removing any scale that has formed from the electrodes in the event that the water softener fails or if there is a significant rise in the electrolysis voltage.

As this unit will be used infrequently and does not directly form part of the sodium hypochlorite generation process, a standby unit is not deemed necessary for this design.

The mobile HCl cleaning system is captured in P&IDs 1001757-2000-PID-PP-2051, 1001757-2000-PID-PP-2052, 1001757-2000-PID-PP-2053 and 1001757-2000-PID-PP-2054.

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5. SODIUM HYPOCHLORITE STORAGE TANKS

5.1 OVERVIEW

The sodium hypochlorite solution generated by each of the four electrolysers will be routed to a common header from where it will feed two sets of two sodium hypochlorite storage tanks that are connected in series.

As hydrogen gas will be produced in the sodium hypochlorite generation process, all equipment fitted to the storage tanks will be ATEX rated.

5.2 STORAGE TANKS

Four storage tanks (2 duty, 2 standby) constructed from fiberglass reinforced plastic (FRP) or a similar suitable material will retain the sodium hypochlorite solution before it is pumped to the dosing points on the inlet and outlet of the reservoir. As each of the two sets of tanks will consist of two storage tanks in series that are connected on the outlet side, blowers to dilute and remove the hydrogen gas will only be required on the first tank in each set.

The storage tanks are captured in P&ID 1001757-2000-PID-PP-2055.

5.3 TANK LEVEL CONTROL

Each of the four storage tanks will be fitted with both an ultrasonic level transmitter as well as high-level and low-level level transmitters. The ultrasonic level transmitter will allow for the operator to continuously monitor the level of sodium hypochlorite solution in the tank via the human machine interface (HMI). The low-level and high-level alarm sensors will provide redundancy to the ultrasonic level transmitter.

Although each set of tanks will be connected in series, both tanks in a series will be fitted with level control instrumentation. This will allow for level monitoring on the second tank in each series when the back-up sodium hypochlorite system is in operation.

Under normal operation, the level control sensors will be used by the PLC to communicate with the sodium hypochlorite generator skids to automatically switch the skids on and off to maintain an adequate supply of sodium hypochlorite in the tanks, and to ensure the tanks do not overflow.

During the operation of the back-up system, the level control sensors will be used to control the filling of the secondary storage tanks with diluted commercial sodium hypochlorite from the dilution injectors.

The tank level control instrumentation is captured in P&ID 1001757-2000-PID-PP-2055.

5.4 BLOWERS

The first tank in each set of tanks will be fitted with two blowers (1 duty, 1 standby). These blowers will dilute the hydrogen gas that is freed from the sodium hypochlorite solution and vent the diluted gas to the atmosphere outside the building. The vent pipe on the first tank in each set of tanks will be fitted with a flow switch which will alarm the operator should the flow of air through this pipe stop at any point.

In the sodium hypochlorite generation process, approximately 5.2 m^3/h of hydrogen gas will be produced in each skid. As two of the generation skids will operate at a time, a total of 10.4 m^3/h of hydrogen gas will be entrained in the product stream sent to the storage tanks. As such, the blowers will blow a minimum of 1040 m^3/h of fresh dilution air into the

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air cavity at the top of the sodium hypochlorite storage tanks. This will ensure that the concentration of hydrogen gas in the headspace of the storage tanks is kept at a concentration below 1% which is well within safety limits.

The hydrogen gas dilution blowers are captured in P&ID 1001757-2000-PID-PP-2055.

5.5 SODIUM HYPOCHLORITE DOSING PUMPS

Sodium hypochlorite dosing pumps will be provided and will receive suction from the sodium hypochlorite storage tanks. The dosing pumps will be installed as two separate skids, each consisting of 2 duty pumps and 1 standby, for the dosing points on the inlet and outlet of the reservoir, respectively. The skids will have all the necessary isolation valves, calibration tube, pulsation dampener, pressure regulating valves, pressure safety valves etc. A Coriolis mass flow meter in the common discharge line will be used to meter off the sodium hypochlorite flow rate and control the flow proportional to the outlet flow via a PID control loop.

The sodium hypochlorite dosing pumps are captured in P&ID 1001757-2000-PID-PP-2056.

5.6 BACK-UP SODIUM HYPOCHLORITE SYSTEM

The design has allowed for a sodium hypochlorite back-up system for periods when the sodium hypochlorite generators are not operational. Commercial sodium hypochlorite will be fed to the first storage tank and diluted using hydraulic-powered chemical injectors. The diluted sodium hypochlorite will feed to the second tank. The dosing pumps will then receive suction from these tanks.

The back-up sodium hypochlorite system is captured in P&ID 1001757-2000-PID-PP-2057.

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6. CALCIUM HYPOCHLORITE PREPARATION AND DOSING

6.1 OVERVIEW

During periods when the sodium hypochlorite generators are not operational, the inlet and outlet of the Muldersvlei Reservoir will be dosed with calcium hypochlorite solution prepared and stored on-site. The calcium hypochlorite preparation process will consist of four dissolving hoppers where calcium hypochlorite chips will be dissolved in service water to produce a 0.08% calcium hypochlorite solution. The solution will be fed to a settling tank where undissolved solids will be allowed to settle out. The supernatant will feed two bulk storage tanks in parallel.

6.2 CALCIUM HYPOCHLORITE DISSOLVING HOPPERS

Four chip-based calcium hypochlorite dissolving hoppers will be used to produce calcium hypochlorite solution at a maximum rate of 6000 L/h.

The calcium hypochlorite dissolving hoppers are captured in P&ID 1001757-2000-PID-PP-2058.

6.3 STORAGE TANKS

The calcium hypochlorite from the hoppers will feed into a receiving tank where undissolved solids will be allowed to settle out. The supernatant, a 0.08% solution of calcium hypochlorite, will feed two storage tanks in parallel. Though the two parallel storage tanks will be connected on the outlet side, both tanks will be equipped with level monitoring instrumentation to increase redundancy in the system.

The calcium hypochlorite storage tanks are captured in P&ID 1001757-2000-PID-PP-2058.

6.4 CALCIUM HYPOCHLORITE DOSING PUMPS

Calcium hypochlorite dosing pumps will be provided and will receive suction from the calcium hypochlorite storage tanks. The dosing pumps will be installed as two separate skids, each consisting of 2 duty pumps and 1 standby, for the dosing points on the inlet and outlet of the reservoir, respectively. Peristaltic dosing pumps will be used for this application.

The skids will have all the necessary isolation valves, calibration tube, pulsation dampener, pressure regulating valves, pressure safety valves etc. A Coriolis mass flow meter in the common discharge will be used to meter off the calcium hypochlorite flow rate and control the flow proportional to the outlet flow via a PID control loop.

The calcium hypochlorite dosing pumps are captured in P&ID 1001757-2000-PID-PP-2059.

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7. LIFTING EQUIPMENT

To allow for the replenishment of sodium chloride bags in the salt dissolution tanks, an overhead travelling crane shall be installed in the building. This crane will have a safe working load (SWL) of 2 tons and be capable of lifting a bag of sodium chloride from the salt bag storage area and transporting these bags to whichever salt dissolution tank is operational. The travelling crane is captured in P&ID 1001757-2000-PID-PP-2050.

Provision has also been made for lifting equipment in each of the pump rooms. The service water pumps will be installed and removed using a fixed gantry with a motorised trolley. This crane will have a SWL of 1 ton. Similarly, the electric-driven and diesel driven centrifugal pumps will each make use of a dedicated electrical gantry crane with a SWL of 2 ton. The service water pump gantry is captured in P&IDs 1001757-2000-PID-PP-2061.

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8. SAFETY EQUIPMENT

8.1 HYDROGEN LEVEL ALARM

The sodium hypochlorite generation process produces hydrogen gas as a by-product. Under normal operation, this hydrogen gas will be transported with the sodium hypochlorite solution to the storage tanks where the gas will be diluted with air and vented to the atmosphere outside the building.

To alert the operators in the case of a hydrogen leak that could cause a potential explosion in the building, two ATEX rated hydrogen alarm sensors (1 duty, 1 standby) will be fitted at the highest point of the ceiling in the building. These hydrogen sensors will be connected to an alarm light and siren to visually and audially alert the operators in an emergency situation, to evacuate the building.

The hydrogen level alarms are captured in P&ID 1001757-2000-PID-PP-2051.

8.2 LEAK DETECTORS

The bulk storage tanks in the sodium hypochlorite generation building will each be within a collecting basin to limit the spreading of liquids in the case of leakage and/or spillage. Each collecting basin will be fitted with a dedicated leak detector. In the event of a spillage, an alarm condition will be initiated, and the operator will inspect the collecting basin.

The leak detectors are captured in P&IDs 1001757-2000-PID-PP-2055 and 1001757-2000-PID-PP-2058.

8.3 SAFETY SHOWER

The sodium hypochlorite generation process will involve the use of chemicals such as hydrochloric acid (HCl), which is caustic and corrosive, and sodium chloride, which is an irritant. As a primary means of treatment, in the event of exposure to these chemicals, two safety showers will be installed in the building to allow for skin or eye rinsing. These safety showers will be fed from the service water line which feed the heat exchanger.

The safety shower is captured in P&ID 1001757-2000-PID-PP-2050.

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9. SERVICES & DOSING

9.1 SERVICE WATER PUMPS

Four service water pumps will provide the sodium hypochlorite generation process and the administration building with service water. The four pumps will be able to provide 5−70 m^3/hr of service water at a pressure of 6 bar. The pumps will be connected to a pressure vessel to achieve the necessary pressure based on system requirements.

The service water pumps are captured in P&ID 1001757-2000-PID-PP-2061.

9.2 SERVICE WATER RETICULATION

Water pumped from the service water pumps shall feed the administration building, guardhouse, and sodium hypochlorite generation building. Inside the sodium hypochlorite generation building, the service water will reticulate to the safety showers, a hose connection, and the heat exchanger.

9.3 FIRE WATER PUMPS

Three fire water pumps will provide the facility with fire water. The system is described and specified in Spec Fire in C3.7.5.

9.4 IRRIGATION WATER SYSTEM

There will be no dedicated irrigation water system. Instead, the irrigation water will be fed from the service water system. The service water system will supply all service water requirements for the site, potable water for the administration building, as well as cleaning water for the reservoir.

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10. BULK WATER CONVEYANCE

10.1 OVERVIEW

Potable water from the Wemmershoek Water Treatment Plant (WTP) will flow into the incoming DN1600 Muldersvlei pipeline via an offtake on the existing DN1600 Wemmershoek pipeline. The water will then be conveyed to the inlet chamber, where under normal operation the manual isolation valves will be configured to direct the flow into the Muldersvlei Reservoir. The inlet flow meter and accompanying actuated inlet valve chamber is installed upstream of the reservoir.

The water will exit the reservoir via two DN1200 outlet pipelines leading to the eastern and western outlet valve chambers, housing manual isolation valves. The two outlet pipelines will terminate into one DN1200 pipeline leading to the Bypass isolation valve chamber. The water will then travel to the outlet flow meter and accompanying actuated dual needle control valves, after which the outgoing pipeline will rejoin with the existing Wemmershoek pipeline, and the water will be directed to Glengarry Reservoir.

10.2 RESERVOIR LEVEL MEASUREMENT

The reservoir top water level (TWL) will be monitored by a water level sensor. Two level sensors will be present in the reservoir with one being the primary and the other as a backup.

10.3 ACTUATED INLET VALVE CHAMBER

The actuated inlet valve chamber will contain a DN1600 electronically actuated butterfly isolation valve. This valve will act as an overflow prevention mechanism for the Muldersvlei reservoir. When the top water level (TWL) of the reservoir is at a critical preset height, the valve will automatically close, thus shutting the supply from Wemmershoek WTP.

10.4 OUTLET CONTROL VALVE CHAMBER

The outlet control valve chamber will house two DN1200 needle control valves. These valves will control the outflow from the Muldersvlei reservoir. The two valves should be able to control the outflow between 50 Mℓ/d and up to 220 Mℓ/d, when operating in parallel.

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3.7.4 CONTROL NARRATIVE

The Control Narrative is included immediately hereafter, comprising 27 pages.

[redacted]

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1. INTRODUCTION

1.1 HIGH LEVEL OVERVIEW

The sodium hypochlorite (NaOCl) generation plant will be located on the site of the Muldersvlei 300 ML reservoir. The purpose of this plant is to produce a disinfectant solution that will be dosed on either the inlet or the outlet of the 300 ML reservoir, to provide residual disinfection in this potable water line.

The primary units in this plant will be the process water cooler, skid-mounted water softener and electrolytic reactor, salt dissolution tanks and the sodium hypochlorite storage tanks. The NaOCl generation process will make use of process water, crystal salt (sodium chloride) and air as inputs and will produce diluted hydrogen gas and NaOCl solution as process outputs.

1.2 GENERAL

This document describes the process control narrative for the Muldersvlei sodium hypochlorite generation plant. It is by no means a comprehensive document and only serves as a guideline to convey the overall control philosophy for the plant. It is the responsibility of the Contractor to provide a detailed control philosophy including all the necessary equipment that is required to achieve the control as described.

It shall be noted that the contents of this document are subject to the Contractors' detailed design of the works. It shall be the responsibility of the Contractor to provide a detailed control philosophy for the plant as well as a Functional Design Specification (FDS) and, operation and maintenance manuals which shall be reviewed and approved by the Engineer.

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2. CONTROL DESCRIPTION

2.1 GENERAL

This section describes the process control required for the Muldersvlei Sodium Hypochlorite Generation Plant. It is by no means a comprehensive control philosophy. The Contractor shall develop a Detailed Control Philosophy and thereafter Functional Design Specification for approval of the Engineer, guided by and expanding upon: the principles given in this section, relevant information in other sections of the Scope of Works, the details shown on the Process and Instrumentation Diagrams (P&ID's) provided by the Employer, detail design requirements from equipment OEM's and suppliers, and by the outcome of the HAZOP study as directed by the Engineer.

2.2 REFERENCE P&ID'S

The applicable P&IDs for the Muldersvlei site are listed in Table 2-1. The control narrative shall be read in conjunction with the process and instrumentation diagrams.

Table 2-1: Reference Process and Instrumentation Diagrams

DESCRIPTION	DOCUMENTATION NUMBER	REVISION
Process Flow Diagram: On-site sodium hypochlorite generation	1001757-2000-PFD-PP-2000	T0
Process Flow Diagram: Sodium hypochlorite dosing pumps and equipment	1001757-2000-PFD-PP-2001	T0
Process Flow Diagram: Commercial sodium hypochlorite dilution	1001757-2000-PFD-PP-2002	T0
Process Flow Diagram: Calcium hypochlorite preparation equipment	1001757-2000-PFD-PP-2003	T0
Process Flow Diagram: Reservoir and pipelines	1001757-2000-PFD-PP-2004	T0
Process and Instrumentation Diagram: Salt dissolution tanks	1001757-2000-PID-PP-2050	T0
Process and Instrumentation Diagram: Sodium hypochlorite generator 1	1001757-2000-PID-PP-2051	T0
Process and Instrumentation Diagram: Sodium hypochlorite generator 2	1001757-2000-PID-PP-2052	T0
Process and Instrumentation Diagram: Sodium hypochlorite generator 3	1001757-2000-PID-PP-2053	T0
Process and Instrumentation Diagram: Sodium hypochlorite generator 4	1001757-2000-PID-PP-2054	T0
Process and Instrumentation Diagram: Sodium hypochlorite storage tanks	1001757-2000-PID-PP-2055	T0
Process and Instrumentation Diagram: Sodium hypochlorite dosing pumps	1001757-2000-PID-PP-2056	T0
Process and Instrumentation Diagram: Commercial sodium hypochlorite dilution	1001757-2000-PID-PP-2057	T0

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DESCRIPTION	DOCUMENTATION NUMBER	REVISION
Process and Instrumentation Diagram: Calcium hypochlorite make-up	1001757-2000-PID-PP-2058	T0
Process and Instrumentation Diagram: Calcium hypochlorite dosing pumps	1001757-2000-PID-PP-2059	T0
Process and Instrumentation Diagram: Service water wet well	1001757-2000-PID-PP-2060	T0
Process and Instrumentation Diagram: Service water pumps	1001757-2000-PID-PP-2061	T0
Process and Instrumentation Diagram: 300 ML reservoir and bulk pipelines	1001757-2000-PID-PP-2062	T0
Process and Instrumentation Diagram: Remote valve chambers and bulk pipelines	1001757-2000-PID-PP-2063	T0

2.3 PROCESS CONTROL SYSTEM

2.3.1 GENERAL

The Muldersvlei sodium hypochlorite generation plant shall be automatically controlled through a Distributed Control System (DCS) and Motor Control Centre (MCC). Only the processes of replenishing salt in the salt dissolution tanks and of cleaning the sodium hypochlorite generator skids with the HCl mobile cleaning system will be manual processes carried out by the operator. In addition to the DCS system, each sodium hypochlorite generator skid will be equipped with an onboard Programmable Logical Controller (PLC) and touch screen Human Machine Interface (HMI) which the operator can use to control and monitor the plant.

The operator shall be able to manually control equipment from the MCC, field control stations (equipped with start and E-stop push buttons) and Local Control Panels (LCP).

2.3.2 OPERATING LEVELS

The following operating levels shall be provided:

a) View-Only level
b) Operator level
c) Supervisor level
d) Maintenance level

2.3.2.1 View-Only Level

This level will be the default 'power up' level for the DCS operation client and will not be password protected. At view-only level, the user will not be able to make any changes and will have access to select equipment & see the associated measured variables.

2.3.2.2 Operator Level

This level will be password protected. The user will be able to carry out any operator functions as well as the following control actions:

a) Selection of automatic / maintenance of plant sections.
b) Editing of set points (where applicable).

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The operator level shall revert back to the view-only level after 10 minutes.

2.3.2.3 Supervisor Level

This level will be password protected. The user will be able to carry out all of the above operator functions as well as the following control actions:

a) Editing of engineering parameters (where applicable).

The supervisor level shall revert back to the view-only level after 10 minutes.

2.3.2.4 Maintenance Level

This level is password protected. The user is able to carry out any maintenance related activities such as

a) Selection of plant sections for maintenance.
b) Editing of set points (where applicable).
c) Editing of engineering parameters. (where applicable)

The maintenance level shall revert back to the view only level after 10 minutes.

2.3.3 OPERATING MODES

The following operating modes shall be provided:

a) Manual mode
b) Automatic mode

2.3.3.1 Manual Mode

Manual mode shall be password protected and selected via a DCS operation client. Each access screen shall be associated with a particular section of the plant. In manual mode, the operator will be required to manually stop/start motors and open/close valves. All safety interlocks shall still be active in manual mode.

2.3.3.2 Automatic Mode

In automatic mode, the control system shall be responsible for all sequencing and interlocking.

2.3.4 PROCESS/ENGINEERING PARAMETERS

Provision shall be made on the DCS systems to allow for the display and modification of process and engineering variables. Access to these parameters shall be password protected. All process variables, i.e., timers etc. shall be accessed in this way and they will not be hard coded. All the process variables shall further be held in a separate database table protected from being overwritten by software updates. A full list of such variables shall be included in the plant operating manual.

2.3.5 PROCESS SET-POINTS

Final setpoint values must be determined and implemented after commissioning when a steady-state operational condition has been achieved. The Supervisor and/or the Engineer shall be able to change the setpoints from the DCS operation client for optimum operation.

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2.3.6 ALARM & INTERLOCK HANDLING

2.3.6.1 Alarms

Operational personnel shall be able to be notified of equipment or process failures via the alarms that will activate visual and audial beacons. The control system shall provide an alarm on the DCS operation client screen if an instruction to an item of equipment to start or stop does not cause that item to start or stop. Active alarms shall be visible on the control room DCS operation clients and MCC HMIs, and can be acknowledged from the DCS operation client, MCC HMI or MCC's.

The alarm interface will be via a pop-up on the screen. When an alarm occurs, a message will also be displayed in the sequence monitor drill out of the DCS, specifying the failed element and the nature of the alarm. Issuing a 'Reset' command from the DCS will be able to clear the alarm if the fault is no longer present.

Alarm conditions which lead to the control system executing an equipment trip shall be logged. Subsequent alarms which occur as a result of the tripping action shall be logged as subordinate alarms. The condition which caused the trip shall be described with respect to the:

a) Item of equipment.

b) Trip set point reached.

c) Description of parameter, i.e., flow, temperature, etc.

d) Time of event.

A time delay following an alarm condition leading to a control system trip shall be incorporated to prevent tripping actions caused by electrical disturbances or similar occurrences. The time delay chosen shall match the functional needs and shall be decided in conjunction with the Engineer.

2.3.6.2 Interlocks

It should be noted that there is an important distinction between process and protection/safety interlocks. Protection interlock violations are alarmed on the DCS and HMI and trip the associated equipment. (All hardwired protection/safety interlocks on the MCC shall also be shown on the DCS/HMI.) Process interlock violations will stop the associated equipment and will log the violation as an event on the DCS.

2.3.6.2.1 Process Interlocks

Process interlocks shall be implemented in automatic mode to ensure:

- The correct sequential operation of equipment and to maintain process variables within normal operating limits.
- Process interlocks are bypassed as long as maintenance mode is selected.
- Typically process interlocks include:
  - High/Low tank and wet well level limits to stop/start pumps.

2.3.6.2.2 Safety Interlocks

Safety interlocks shall be implemented in both automatic and manual mode to:

- Prevent damage to equipment; and
- Prevent injury to personnel.

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Following the violation of a safety interlock, deliberate operator action shall be required (e.g., reset) to return the device to normal operation. The reset functionality is provided at the DCS or HMI.

Safety interlocks shall not be bypassed.

Typically, safety interlocks include:

- High/Low tank level limit to trip pumps for overfill protection or a dry run
- Low/No flow switches
- High/Low pressure in the system
- High temperature

2.3.6.2.3 Critical Control Point Interlocks

Critical Control Point Interlocks shall be active in all modes:

Critical Control Point Interlocks shall not be bypassed regardless of the mode.

2.3.7 DCS OPERATION SCREENS

2.3.7.1 Mimic Screens

Refer to electronic specification for further details of mimic screens to be provided.

2.3.8 RECOVERY FROM POWER FAILURE

After a power failure all outputs will be switched off, including the control power to the outputs. There shall be no loss of sequence steps or data. Depending on the operating state the system will be restarted as follows:

Manual Mode: All outputs will have to be restarted manually.

Automatic Mode: If the plant section was not in a 'Passive' state then the process will revert to 'Hold'. The 'Continue' command will need to be used to continue production.

2.3.9 ACTUATED VALVE OPERATION

Where applicable, all pneumatic solenoid valves will be timed to ensure that they move to their correct position within a pre-set time. After this time, they are checked continuously. A failure to prove the correct state (i.e. fail to open or fail to close) will be enunciated as an alarm. A unique pre-set time will be allocated for each valve.

a) For a normally closed (de-energised) valve, when energised, the valve is healthy if its opened limit switch is high (limit made), and its closed limit is low (limit not made).

b) For a normally closed (de-energised) valve, when de-energised, the valve is healthy if its closed limit switch is high (limit made), and its opened limit is low (limit not made).

c) For a normally opened (de-energised) valve, when energised, the valve is healthy if its closed limit switch is high (limit made), and its opened limit is low (limit not made).

d) For a normally opened (de-energised) valve, when de-energised, the valve is healthy if its opened limit switch is high (limit made), and its closed limit is low (limit not made).

2.3.10 MOTOR STARTING, STOPPING & OVERLOAD

Refer to electrical specification for further details.

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2.3.11 STANDARD OPERATING DEFINITIONS

2.3.11.1 Commands

Commands will be used to control the execution of a task. They are provided through the DCS.

The following DCS commands will be provided:

'Navigation'	Navigation buttons are provided to access all screens.
'Mode'	The mode of each section of plant can be changed by the Operator to either Maintenance or Automatic.
'Menu'	Returns the user to the appropriate menu page.
'Reset'	Resets the alarm condition once the cause of the alarm has been rectified e.g. if a motor has tripped, the overload has been manually reset, pressing 'Reset' will energise the motor if sequence conditions permit it.

2.3.11.2 Status Information

Status information will be communicated to the user via the DCS. This information will consist of:

Execution State:

This information will indicate the progress of the job that is being executed at that time. It will help the user to supervise the execution of the job. A job can be in only one state at a time.

Fault Information:

This information will be independent of job execution. As soon as a fault occurs an alarm message will be indicated on the DCS. A fault will not necessarily influence the execution state of the job.

2.3.12 TESTING & COMMISSIONING OF CONTROL SYSTEM

The Contractor shall submit a schedule of all control functions to be checked on site during testing and commissioning. This shall be submitted for approval by the Engineer. The Contractor is also referred to the Electronic Specification for further instructions:

2.4 DATA LOGGING & TRENDING

The parameters presented in Table 2-2 will be made available for continuous monitoring & recording of operational data via the plant PLC & SCADA system. In addition to online monitoring, some process parameters will also be manually sampled and analysed via the onsite laboratory. For these, the plant operator will record data daily on a 2 or 4 hourly basis. The frequency of data recording will be determined after a period of steady state operation. The manually recorded data will be checked against the online data to identify any outliers.

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Table 2-2: 300 ML Muldersvlei Reservoir DCS Trending

PARAMETER	UNITS	SPECIFICITY OF READING	SUGGESTED LOGGING INTERVALS IN DCS DATABASE
Totalised flows	kL	0.001	1–5 min
Instantaneous flows	L/s	1	30 s – 2 min
Levels	m	0.01	on change >1%
Temperature	°C	0.1	5–10 min
Residual chlorine	mg/l	0.1	30 s – 2 min
	All Motor Control Centres		
Pump/Motor run hours	hrs		5 min
Pump/Motor in fault and Run condition	On/Off		on change
Energy instantaneous usage	kW		30 s – 2 min
Energy usage	kWh		5 min
Comms fail	On/Off		on change
Efficiency (Pump set/ Pump Station/ Equipment)	%		5 min

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3. CONTROL NARRATIVE – SODIUM HYPOCHLORITE GENERATION PLANT

3.1 PROCESS WATER COOLER

The process water cooler will include the following units:

- Plate Heat Exchanger (98-HX-001)
- Chiller (98-CT-001)
- Flow Switch (98-FS-001)
- Temperature Transmitter (98-TT-001/2)

3.1.1 PRIMARY EQUIPMENT

The primary equipment for the process water cooler will be located in the sodium hypochlorite generation building. The process water cooler system shall be fed with water from the service water pumps. After passing through the process water cooler system, process water will be fed, through a common header, to the four sodium hypochlorite generators.

The process water cooler equipment and instrumentation are captured in P&ID 1001757-2000-PID-PP-2050.

3.1.2 PROCESS OBJECTIVES

The sodium hypochlorite generation process will require process water within a temperature range of 12.7–26.7 °C. Based on the site location in Muldersvlei, and the fact that the process water will be sourced from the large reservoir on site, it is envisaged that the process water may require cooling during the hottest 2–3 months of the year. It is deemed very improbable that the temperature of the incoming process water will be less than the minimum required temperature of 12.7 °C, and for this reason provision has not been made to include a process water heater in this design. Therefore, the overarching purpose of the process water cooler is to ensure that the sodium hypochlorite generators receive water within the required temperature range.

3.1.3 SYSTEM DESCRIPTION

Process water entering the sodium hypochlorite generation process will first pass through a plate heat exchanger. The plate heat exchanger (98-HX-001) shall allow for process water to be cooled from 26 °C to 16 °C, with the counterflow chilled water warming from 11 °C to 16 °C between inflow and outflow respectively.

A water chiller (98-CT-001) will feed the plate heat exchanger with chilled water. This water chiller will connect, via PLC, to a flow switch (98-FS-001) and temperature transmitter (98-TT-002) installed on the process water stream feeding the heat exchanger. These instruments will trigger the chiller to operate when there is flow detected in the process water line and when the temperature of the process water is simultaneously detected to be higher than 26 °C. If any of these two conditions is not met, the chiller will not operate, and the process water will flow through the heat exchanger without any heat transfer to chilled water.

Table 3-1 summarises the process water cooler objectives.

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Table 3-1: Process Water Cooler Objectives

TAG NO	DESCRIPTION	DESIRED TARGET	ALERT LEVEL	TRIGGER LEVEL
98-FS-001	Heat exchanger inlet flow switch	NA	NA	Flow Detected
98-TT-002	Heat exchanger inlet temperature transmitter	< 26 °C	> 26 °C	> 26 °C

3.2 SALT DISSOLUTION TANKS

Each salt dissolution tank will include the following units:

- Concrete Tank (45-TK-001/2)
- Actuated Valve on the Inlet Stream (45-XV-001/3)
- Actuated Valve on the Outlet Stream (45-XV-002/4)
- Radar Salt Level Monitor (45-LT-001/2)
- Four Level Switches on each tank (45-LAL-001/2, 45-LSL-001/2, 45-LSH-001/2, 45-LAH-001/2)

In addition, an overhead travelling crane (45-CR-001) will transport salt bags to both salt dissolution tanks.

3.2.1 PRIMARY EQUIPMENT

The salt dissolution tanks will be located in the sodium hypochlorite generation building where they will be loaded with salt bags and fed with softened water from the water softeners incorporated into the sodium hypochlorite generators.

The salt dissolution tank equipment and instrumentation are captured in P&ID 1001757-2000-PID-PP-2050.

3.2.2 PROCESS OBJECTIVES

The primary purpose of the salt dissolution tanks is to provide the sodium hypochlorite generators with a saturated salt (sodium chloride) solution to produce the sodium hypochlorite solution.

Two salt dissolution tanks (1 duty, 1 standby) shall be fed, via a common header, with softened water from the water softeners onboard the four sodium hypochlorite generators. Salt bags will be manually placed in the tanks to ensure the water in the tanks is constantly saturated with salt. The saturated brine solution produced in the salt tanks will feed, via a common header, the electrolytic reactors onboard the four sodium hypochlorite generators.

3.2.3 SYSTEM DESCRIPTION

Each salt dissolution tank will be fitted with four level switches. Two of the level switches will provide a low-level alarm (45-LAL-001/2) and high-level alarm (45-LAH-001/2) to the operator, and the other two level switches (45-LSL-001/2 & 45-LSH-001/2) will provide low-level and high-level control points to maintain the water level in the tank.

These level switches will control an actuated valve on the inlet pipe to each tank to allow for automatic filling of the tank. When the low-level switch (45-LSL-001/2) registers no water

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at that level, the actuated valve (45-XV-001/3) will automatically be opened until the water level reaches the high-level switch (45-LSH-001/2), at which point the actuated valve will automatically be closed to ensure the tank does not overflow.

If the water level in the tank reaches the high-level alarm switch (45-LAH-001/2) an audible and visual alarm will be triggered via the DCS and the actuated valve will be closed automatically. If the low-level alarm switch registers that there is no water at that level, an audible and visual alarm will be triggered via the DCS and an actuated valve on the incoming line to the salt dissolution tank will be opened.

In addition to the level switches that will control the water level in the salt dissolution tanks, each tank will also be fitted with a radar salt level monitor (45-LT-001/2). This radar level monitor will continuously measure the level of crystal sodium chloride inside the salt bag and this level will be presented on the DCS HMI. If the salt level drops below the defined low-level, a visual and audible alarm will be triggered on the DCS to alert the operator to replenish the salt bag. This salt level monitor will be installed on a movable arm to allow the instrument to be moved out of the path of the salt bag as it is being placed in the tank.

An overhead travelling crane will be used to manually replenish salt bags in the salt dissolution tanks to ensure a saturated brine solution is maintained in the tanks. This system is discussed in more detail in section 3.11.

Table 3-2 summarises the salt dissolution tank objectives. The Contractor will confirm these values.

Table 3-2: Salt Dissolution Tank Objectives

TAG NO	DESCRIPTION	DESIRED TARGET	ALERT LEVEL	TRIGGER LEVEL
45-LT-001	Radar salt level monitor	20–100% of working volume	< 20% of working volume	Level Detected
45-LAL-001	Salt dissolution tank low-level alarm	> 20% of working volume	< 20% of working volume	Level Detected
45-LAH-001	Salt dissolution tank high-level alarm	100% of working volume	> 95% of working volume	Level Detected
45-LSL-001	Salt dissolution tank low-level switch	> 40% of working volume	< 40% of working volume	Level Detected
45-LSH-001	Salt dissolution tank high-level switch	< 70% of working volume	> 70% of working volume	Level Detected

3.3 SODIUM HYPOCHLORITE GENERATORS

Each sodium hypochlorite generator will include the following units:

- Onboard Water Softener (45-SPE-001/2/3/4)
- Brine Pump (45-PMP-001/2/3/4)

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[redacted]

- Actuated Valve (45-XV-005/6/7/8)
- Temperature Switch (45-TS-002/4/6/8)
- Flow Transmitter (45-FT-001/2/3/4)
- Electrolytic Reactor (45-ER-001/2/3/4) with an Onboard Level Switch (45-LS-009/10/11/12) and Onboard Temperature Transmitter (45-TT-002/4/6/8)

3.3.1 PRIMARY EQUIPMENT

The sodium hypochlorite generators are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2051
- 1001757-2000-PID-PP-2052
- 1001757-2000-PID-PP-2053
- 1001757-2000-PID-PP-2054

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.3.2 PROCESS OBJECTIVES

The sodium hypochlorite generation process will include four sodium hypochlorite generators (2 duty, 2 standby). Each of these generators will be skid-mounted units including an onboard water softener and an onboard electrolytic reactor. Each skid will be fed by two incoming streams: process water from the heat exchanger and brine from the salt dissolution tanks; and will produce two outgoing streams: softened water fed to the salt dissolution tanks and sodium hypochlorite solution fed to the storage tanks.

A mobile HCl cleaning system is included in this design and will allow for each of the skid mounted units to be cleaned by an operator to remove the build-up of contaminants over time.

3.3.3 SYSTEM DESCRIPTION

The labelling in the following paragraph pertains specifically to Sodium Hypochlorite Generator 1 (45-EC-001) and its associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Sodium Hypochlorite Generator 2 (45-EC-002), Sodium Hypochlorite Generator 3 (45-EC-003) and Sodium Hypochlorite Generator 4 (45-EC-004) with the respective equipment and instrumentation.

3.3.3.1 Onboard Water Softener

The process water stream to each sodium hypochlorite generator will first pass through a water softener that will contain a cationic resin which will absorb calcium and magnesium ions from the water and exchange them with sodium ions via the ion exchange process. There will be no actuated valve on the incoming line to the water softeners and therefore the water softener vessels will always be full of water unless the manual isolation valve on the inlet line is closed by the operator.

The softener will be equipped with an automatic control head (45-FT-001) which displays the cumulative flow rate of softened water and/or the time that has lapsed since the last regeneration. The regeneration of the softener using brine solution will be automatically initiated based on either cumulative flow or time, as selected by the operator. Once

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regeneration of the softener is initiated, the control head will allow for an automatic switch-over to the standby softener.

The hardness of the outlet line from the water softener will firstly be monitored via an online hardness analyser (45-AE-001). If the analyser registers a water hardness greater than 10 mg/L, an audible and visual alarm will be triggered via the DCS, and the operator will initiate a regeneration cycle.

The pressure of the outlet line from the water softener will then be monitored via a pressure gauge (45-PG-001) before the softened water stream is diverged into two streams feeding the salt dissolution tanks and the onboard electrolytic reactors.

3.3.3.2 Electrolytic Reactor

The softened water feed stream to the electrolytic reactor shall be fitted with an actuated valve (45-XV-005). The volume, pressure, and flow of the softened water feed stream to the electrolytic reactor will also be monitored through a volume flow regulator, pressure gauge (45-PG-002) and a flow transmitter (45-FT-002) before the stream is diverged into two streams. The electrolytic reactor will be fed through two lines, namely the dilution water line and the saturated brine line. The saturated brine solution from the salt dissolution tank will be pumped by an onboard pump (45-PMP-001) fitted with a speed indicator controller (45-SIC-001). The saturated brine line will then be combined with one of the divergent softened water streams that shall be fitted with a temperature transmitter (45-TT-001) to monitor and ensure that the temperature of that stream is within the operating range, 12.7−26 °C. If the stream temperature is not within the operating range, an audible alarm will be triggered to alert the operator. The saturated brine and softened water lines will be fitted with onboard control valves and rotameters (45-ZS-001/2/3) to ensure that the optimum dilution ratio between the dilution water line and diluted brine line is achieved before entering the electrolytic reactor.

The electrolytic reactor will be fitted with a temperature transmitter (45-TT-002) and level switch (45-LS-009) to monitor the temperature and water level inside each reactor. During the start-up of the electrolytic reactor, the water level must first be monitored until the minimum operating water level is reached before the electrolytic reactor is switched on.

During operation, if the temperature reaches the high-temperature alarm switch (45-TAH-001) an audible and visual alarm will be triggered via the DCS to alert the operator and the electrolytic reactor will automatically switch off. Additionally, the actuated valve (45-XV-005) on the softened water feed stream and the speed indicator controller (45-SIC-001) on the onboard brine pump (45-PMP-001) will automatically switch to close mode to stop the inlet flows. The cause of the high temperature will then be investigated and resolved before the electrolytic reactor is switched on by following the start-up procedure.

If the low-level alarm switch (45-LAL-003) registers that the water level is below the minimum operating water level, an audible and visual alarm will also be triggered via the DCS to alert the operator and the electrolytic reactor will automatically switch off while the actuated valve (45-XV-005) and the speed indicator controller (45-SIC-001) will still be on open mode to allow the water level inside the reactor to rise. Once the minimum operating water level is reached, the electrolytic reactor will automatically restart.

Table 3-3 summarises the electrolytic reactor objectives.

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Table 3-3: Electrolytic Reactor Objectives

TAG NO	DESCRIPTION	DESIRED TARGET	ALERT LEVEL	TRIGGER LEVEL
45-FT-002	Electrolytic reactor softened water inlet flow transmitter	1136 L/h	Supplier defined	Flow detected
45-TT-001	Electrolytic reactor softened water inlet temperature transmitter	12.7–26 °C	>26 °C	Temperature Detected
45-ZS-001/2/3	Electrolytic reactor softened water inlet position switch	Supplier defined	Supplier defined	Position Detected
45-LS-009	Electrolytic reactor level switch	Supplier defined	Supplier defined	Level Detected
45-TT-002	Electrolytic reactor temperature transmitter	12.7–46 °C	<47 °C	Temperature Detected

3.4 SODIUM HYPOCHLORITE STORAGE TANKS

Sodium hypochlorite storage tank system will include the following units:

- Four Fiberglass Reinforced Plastic (FRP) Storage Tanks (46-TK-001/2/3/4) with two sets of tanks in series
- Eight Level Switches (46-LS-002/3/6/7, 46-LS-004/5/8/9)
- Ultrasonic Level Monitors (46-LT-001/2)
- Flow Switches (46-FAL-001/2)
- Four Storage Tank Blowers (46-BL-001/2/3/4)

3.4.1 PRIMARY EQUIPMENT

The sodium hypochlorite storage tanks are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2055

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.4.2 PROCESS OBJECTIVES

The first objective of the two sets of fiberglass reinforced plastic (FRP) storage tanks in series will be to store the sodium hypochlorite solution generated from the four electrolytic reactors. The second objective will be to ensure safe and continuous storage and supply of sodium hypochlorite to provide residual disinfection in the outlet stream of the 300 ML Muldersvlei reservoir. Additionally, due to the formation of hydrogen during the electrolytic reaction, all equipment surrounding the storage tanks will be ATEX rated.

An additional objective of the storage tanks will be to store commercial (12%) sodium hypochlorite and diluted commercial sodium hypochlorite (0.8%). This will form part of the back-up system for the periods where the on-site sodium hypochlorite generation skids are not operational. The control and operation of this system are discussed in Section 183.6.

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3.4.3 SYSTEM DESCRIPTION

The labelling in the following paragraph pertains specifically to the set of Sodium Hypochlorite Storage Tanks 1 and 2 in series (46-TK-001/2) and its associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Sodium Hypochlorite Storage Tanks 3 and 4 in series (46-TK-003/4), with the respective equipment and instrumentation.

3.4.3.1 Sodium Hypochlorite Storage Tanks in Series

The generated sodium hypochlorite solution shall be fed into two sodium hypochlorite storage tanks in series (46-TK-001/2). Both storage tanks will be connected through a line fitted with a manual valve and the sodium hypochlorite solution will be fed into the second tank from the first tank. The preparation of sodium hypochlorite, i.e., the operation of the onsite sodium hypochlorite generation plant, is controlled via the fill level of the storage tank. Sodium hypochlorite preparation stops once the storage tank is full, i.e., the maximum level storage tank is reached. Once the minimum storage tank level is reached, the preparation of the sodium hypochlorite solution automatically starts again.

Therefore, to monitor the storage tank level across both tanks in series, the first sodium hypochlorite storage tank in series (46-TK-001) will be fitted with two level switches (46-LS-002/4). The level switches will provide a low-level alarm (46-LAL-001) and high-level alarm (46-LAH-001) to the operator, and these switches will also provide a low-level and high-level control point to maintain the sodium hypochlorite level in the tank.

Although these will not be used for level control, the second storage tank in series will also be fitted with two level switches (46-LS-003/5). The operator may monitor the switches on both tanks to ensure that all instrumentation is operating satisfactorily.

The level switches on the first tank will control the operation of the sodium hypochlorite generator to allow for an automated production of sodium hypochlorite and the filling of the storage tanks respectively. When the low-level switch (46-LS-002) registers no sodium hypochlorite at that level, the generation of sodium hypochlorite will automatically restart by firstly allowing the brine solution and softened water to be fed into the generator. Once the minimum operating level in the reactor is reached, the sodium hypochlorite generator will automatically switch on and the generated sodium hypochlorite solution will feed into the storage tank. Once the sodium hypochlorite solution level reaches the high-level switch (46-LS-004), the sodium hypochlorite generator will automatically switch off to stop the production of the solution and avoid an overflow.

If the sodium hypochlorite solution level in the first tank reaches the high-level alarm switch (45-LAH-001) an audible and visual alarm will be triggered via the generator will be shut down automatically. If the low-level alarm switch registers that there is no sodium hypochlorite solution at that level, an audible and visual alarm will be triggered via the DCS, and the generator will be started up.

In addition to the level switches that will control the sodium hypochlorite solution level in the storage tank, the first tank in series will also be fitted with an ultrasonic level transmitter (46-LT-001). This level transmitter will continuously measure the level of sodium hypochlorite solution and this level will be presented on the DCS HMI. If the solution level rises above the defined high-level, a visual and audible alarm will be triggered on the DCS to alert the operator and the generator will be automatically shut down to ensure that the tank does not overflow.

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The Contractor shall propose a suitable start-up and shut-down sequence for the sodium hypochlorite generation skid. In other words, the Contractor will decide the order in which the actuated valve on the softened water feed line (45-XV-005/7/9/11), the brine pump (45-SIC-001/2/3), and the electrolytic reactor (45-ER-001/2/3/4) will be switched on or off to start up or shut down the generation skid.

3.4.3.2 Storage Tank Blower

The electrolytic reaction of diluted brine also results in the formation of gaseous hydrogen (H_2) which flows along with the sodium hypochlorite solution into the storage tank. In the storage tank, the hydrogen is released, mixes with the air and forms a highly explosive mixture. To limit the risks of explosion, the first sodium hypochlorite storage tank in series will be fitted with an air con system. The air con system will be made of two blowers in a duty (46-BL-001), standby (46-BL-002) configuration. The blower on duty will continuously flush the storage tank with air to dilute the hydrogen to a safe concentration and blow it via a vent pipe into the open air. The blowers shall be ATEX certified radial fans with a suction filter fitted with a non-return valve.

At start-up, the fan of the blower (46-FN-001) shall switch on automatically once the sodium hypochlorite solution is fed into the storage tank. If the blower on duty stops, the standby blower shall automatically start, and the notification must be sent to the DSC to alert the operator. If there is any issue with both blowers causing both blowers to be non-operational, the entire sodium hypochlorite generation plant shall immediately shut down through the integrated air flow monitor switch (46-FS-001) to prevent any additional feeding. A notification/alarm shall be triggered to alert the operator. After inspection of the standby storage system to ensure that the system is ready for operation, the operator will manually restart the plant and feed the sodium hypochlorite product to the standby storage tank.

The diluted hydrogen will be vented into the open air via a vent pipe fitted with an air flow monitor (46-FS-001). If the high-flow alarm switch (46-FAL-001) registers that the hydrogen concentration is above the safe concentration (1%), an audible and visual alarm will be triggered via the DCS to alert the operator and the sodium hypochlorite generator will automatically shut down.

3.5 SODIUM HYPOCHLORITE DOSING PUMPS

The sodium hypochlorite dosing pumps process consists of the following systems:

- NaOCl Dosing Pumps

3.5.1 PRIMARY EQUIPMENT

The sodium hypochlorite dosing pumps are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2056

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.5.2 PROCESS OBJECTIVES

The objective of the sodium hypochlorite dosing pumps is to dose the sodium hypochlorite solution from the sodium hypochlorite storage tanks into the inlet of the 300ML Muldersvlei Reservoir.

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3.5.3 SYSTEM DESCRIPTION

The labelling in the following paragraph pertains specifically to the set of Sodium Hypochlorite Dosing Pumps 1, 2 and 3 (46-PMP-001/2/3) to be used for dosing at the reservoir inlet and the associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Sodium Hypochlorite Dosing Pumps 4, 5 and 6 (46-PMP-004/5/6) to be used for dosing at the reservoir outlet, with the respective equipment and instrumentation.

The generated 0.8% sodium hypochlorite solution is stored in the sodium hypochlorite storage tanks in series from which the solution is dosed into the inlet of the 300ML Muldersvlei Reservoir. The NaOCl dosing pumps will be in a two duty, one standby configuration and will be used to withdraw the solution at the defined dosing rate proportional to the inlet flowrate of the Muldersvlei Reservoir. This shall be achieved using the Variable Speed Drive on the dosing pump to maintain the correct mass flow rate) of sodium hypochlorite solution as measured by the Coriolis mass flowmeter (46-FT-001) for a desired dosing rate as selected by the operator. In addition, each pump shall be fitted with a flow detector (46-FAL-001/2/3) and a pressure gauge (46-PG-001/2/3) on the discharge side to regulate the flowrate and pressure of the sodium hypochlorite solution.

The pumps will also include interlocks to switch off the pumps when a low level is reached in the storage tanks.

3.6 COMMERCIAL SODIUM HYPOCHLORITE DILUTION SYSTEM

The commercial sodium hypochlorite dosing pumps process consists of the following systems:

- Hydraulic-powered Chemical Injectors (46-VTR-001/2)
- Four Fiberglass Reinforced Plastic (FRP) Storage Tanks (46-TK-001/2/3/4)
- Eight Level Switches (46-LS-002/3/6/7, 46-LS-004/5/8/9)
- Ultrasonic Level Monitors (46-LT-002/4)
- Commercial Sodium Hypochlorite Actuated Valve (46-XV-001)
- Service Water Actuated Valve (46-XV-002)

3.6.1 PRIMARY EQUIPMENT

The commercial sodium hypochlorite dilution system is comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2055
- 1001757-2000-PID-PP-2057

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.6.2 PROCESS OBJECTIVES

The objective of the commercial sodium hypochlorite dilution system is to provide a back-up source of disinfection for the Muldersvlei Reservoir during the periods when the on-site sodium hypochlorite generators are not operational. This will be achieved by the storage and dilution of commercial sodium hypochlorite which will then be fed to the dosing pumps.

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3.6.3 SYSTEM DESCRIPTION

The labelling in the following paragraph pertains specifically to the set of Sodium Hypochlorite Storage Tanks 1 and 2 (46-TK-001/2) and their associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Sodium Hypochlorite Storage Tanks 3 and 4 in series (46-TK-003/4), with the respective equipment and instrumentation.

The first storage tank (46-TK-001) will be filled with 12% sodium hypochlorite solution using manual control from the delivery truck. The level gauge on the tank (46-LG-001) as well as the mechanical flow meter on the delivery line (46-FT-001) shall be used by the operator to terminate the filling operation when tank is approaching a full level.

Once the filling has been terminated, 12% sodium hypochlorite will begin feeding the hydraulic-powered chemical injectors (46-VTR-001/2) by opening the actuated valve on the chemical suction line (46-XV-001). The actuated valve in the service water feed line (46-XV-002) will then be opened to allow for the dilution to commence.

The diluted sodium hypochlorite will be fed to the second storage tank (46-TK-002). If the sodium hypochlorite solution level in the tank reaches the high-level alarm switch (45-LAH-002) an audible and visual alarm will be triggered via the DCS and the actuated valve on the service water line will be closed automatically.

Additionally, if the sodium hypochlorite level in the first storage tank reaches the low-level alarm switch (45-LAL-002), an audible and visual alarm will be triggered via the DCS and the actuated valve on the service water line will also be closed automatically to terminate the dilution process.

The manual 3-way isolation valves around the chemical injectors (46-ZS-009/12) will be fitted with limit switches to show the OPEN/CLOSE status of the valves on the SCADA system. These limits must be programmed such that the system reads for the correct set of storage tanks. In other words, the limits shall be programmed to ensure that the chemical injector that is in operation feeds to the correct tank set that is in operation.

In addition to the level switches that will control the sodium hypochlorite solution level in the storage tank, the second storage tank will also be fitted with an ultrasonic level transmitter (46-LT-002). This level transmitter will continuously measure the level of sodium hypochlorite solution and this level will be presented on the DCS HMI. If the solution level rises above the defined high-level, a visual and audible alarm will be triggered on the DCS to alert the operator and the actuated valve on the service water line will automatically be closed to ensure that the tank does not overflow.

3.7 CALCIUM HYPOCHLORITE STORAGE TANKS

The calcium hypochlorite storage tank system will include the following units:

- Four Calcium Hypochlorite Solution Preparation Units
- One Calcium Hypochlorite Solution Receiving Tank (47-TK-001)
- Two Calcium Hypochlorite Storage Tanks (47-TK-003/4) installed in parallel
- Two Level Switches (47-LS-001/2, 47-LAL-001/2)
- Ultrasonic Level Monitors (47-LT-001/2)

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3.7.1 PRIMARY EQUIPMENT

The calcium hypochlorite storage tanks comprise of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2058

This equipment will be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.7.2 PROCESS OBJECTIVES

The objective of the calcium hypochlorite storage system is to provide a back-up source of disinfection for the Muldersvlei Reservoir during the periods when the on-site sodium hypochlorite generators are not operational. This will be achieved by the dissolution of calcium hypochlorite chips in water to produce 0.08% calcium hypochlorite solution. The calcium hypochlorite solution will be settled in the receiving tank and will overflow into two parallel storage tanks. These storage tanks will provide continuous storage and supply of calcium hypochlorite for disinfection of the 300 ML Muldersvlei reservoir.

3.7.3 SYSTEM DESCRIPTION

3.7.3.1 Calcium Hypochlorite Preparation

In the event that the sodium hypochlorite generators are not operational, the calcium hypochlorite preparation will be initiated. The actuated valve on the service water supply line (47-XV-001) will be opened and water will feed the calcium hypochlorite chips dissolving hoppers (47-HP-001/2/3/4). This will produce calcium hypochlorite solution which will feed the receiving tank (47-TK-001). This tank will act as a settler for any sediment generated during the preparation of calcium hypochlorite solution.

3.7.3.2 Calcium Hypochlorite Storage Tanks in Parallel

The supernatant from the settling tank will be routed via gravity to two parallel installed calcium hypochlorite storage tanks (47-TK-002/3). The two storage tanks will be connected at the bottom through a line fitted with a manual valve. The preparation of calcium hypochlorite shall be controlled via the fill level of the storage tanks. Calcium hypochlorite preparation stops once the storage tank is full, i.e., the maximum level storage tank is reached. Once the minimum storage tank level is reached, the preparation of the sodium hypochlorite solution automatically starts again.

To monitor the storage tank level across each tank, both of the storage tanks shall be fitted with two level switches. The level switches will provide a low-level alarm (47-LAL-001) and high-level alarm (47-LAH-001) to the operator, and these switches (47-LS-002 & 47-LS-003) will also provide a low-level and high-level control point to maintain the calcium hypochlorite level in the tank.

These level switches will control the operation of the calcium hypochlorite preparation units via opening of the actuated valved (47-XV-001) in the water supply line to the calcium hypochlorite hoppers. Opening of the valve will allow water spray onto the calcium bed and the solution will be gravity fed into the receiving tank (47-TK-001).

If the calcium hypochlorite solution reaches the high-level alarm switch (47-LAH-001/2) an audible and visual alarm will be triggered via the DCS and the actuated valve will be closed automatically. If the low-level alarm switch registers that there is no calcium hypochlorite solution at that level, an audible and visual alarm will be triggered via the DCS and actuated valve on the service water will be opened.

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In addition to the level switches that will control the calcium hypochlorite solution in the storage tanks, the tank will also be fitted with an ultrasonic level transmitter (47-LT-001). This level transmitter will continuously measure the level of calcium hypochlorite solution, and this level will be presented on the DCS HMI. If the solution level rises above the defined high-level, a visual and audible alarm will be triggered on the DCS to alert the operator, and the actuated valve will automatically be closed to ensure that the tank does not overflow.

3.8 CALCIUM HYPOCHLORITE DOSING PUMPS

The calcium hypochlorite dosing pumps process consists of the following systems:

- $Ca(ClO)_2$ Dosing Pumps

3.8.1 PRIMARY EQUIPMENT

The calcium hypochlorite dosing pumps are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2059

This equipment shall be monitored, controlled and protected by the control system with controls and statuses displayed on the operator interfaces.

3.8.2 PROCESS OBJECTIVES

The objective of the calcium hypochlorite dosing pumps is to dose the calcium hypochlorite solution from the calcium hypochlorite storage tanks into the inlet and/or outlet of the 300ML Muldersvlei Reservoir.

3.8.3 SYSTEM DESCRIPTION

The labelling in the following paragraph pertains specifically to the set of Calcium Hypochlorite Dosing Pumps 1, 2 and 3 (47-PMP-001/2/3) to be used for dosing at the reservoir inlet and the associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Calcium Hypochlorite Dosing Pumps 4, 5 and 6 (47-PMP-004/5/6) to be used for dosing at the reservoir outlet, with the respective equipment and instrumentation.

The generated 0.08% calcium hypochlorite solution is stored in the calcium hypochlorite storage tanks in parallel, from which the solution is dosed into the inlet of the 300ML Muldersvlei Reservoir. The calcium hypochlorite dosing pumps will be in a two duty, one standby configuration and will be used to withdraw the solution at the defined dosing rate proportional to the inlet flowrate of the Muldersvlei Reservoir. This shall be achieved using the Variable Speed Drive on the dosing pump to maintain the correct mass flow rate of solution as measured by the Coriolis mass flowmeter (47-FT-002) for a desired dosing rate selected by the operator. In addition, each pump shall be fitted with a flow detector (47-FAL-001/2/3) and a pressure gauge (47-PG-001/2/3) on the discharge side to regulate the flowrate and pressure of the calcium hypochlorite solution.

The calcium hypochlorite dosing system will include safety interlocks to ensure that these pumps do not operate at the same time as the sodium hypochlorite dosing pumps. The pumps will also include interlocks to switch off the pumps when a low level is reached in the two calcium hypochlorite storage tanks.

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3.9 SERVICE WATER SYSTEM

The service water system consists of the following systems:

- Service Water Wet Well Level Control Valve (74-LCV-001)
- Service Water Wet Well Level Sensors (74-LT-001/2)
- Service Water Pumps
- Service Water Pressure Accumulator

3.9.1 PRIMARY EQUIPMENT

The service water pump system is comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2061

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.9.2 PROCESS OBJECTIVES

The objective of the service water pumps is to supply the sodium hypochlorite generation building, the irrigation system, and the administration building with potable water from the service water wet well.

3.9.3 SYSTEM DESCRIPTION

The service water pumps will draw from the service water wet well. The level instrumentation on the wet well will interlock with the pumps such that the pumps will automatically switch off when the wet well reaches a low level. The pumps (74-PMP-001/2/3/4) will provided as a vendor package and will operate as a pressure booster set. In the cases where the water demand on site only requires a single pump to be in operation, the pump set will automatically alternate the pump on duty.

The labelling in the following paragraph pertains specifically to the Service Water Pump 1 (74-PMP-001) and its associated equipment and instrumentation. However, the system employed in the description shall also be applicable to Service Water Pumps 2, 3 and 4 (74-PMP-002/3/4) with the respective equipment and instrumentation.

The service water pump (74-PMP-001) shall be fitted with a pressure indicator on the suction (74-PI-001) and discharge side (74-PI-002) to monitor the pressure across the pump. A flow switch (74-FS-001) will also be fitted on the discharge side to monitor the outlet flowrate. If the outlet flowrate is below the minimal flowrate, an alarm (74-FAL-001) will be triggered to alert the operator, and the pump (74-PMP-001) will automatically shut down to prevent the cavitation of the pump. The combined discharge manifold will be equipped with a pressure accumulator (74-TK-001), a magnetic flow transmitter (74-FT-001) and, a pressure transmitter (74-PT-001) to regulate the flowrate and pressure in the service water discharge line.

3.10 SAFETY EQUIPMENT

The safety equipment system consists of the following systems:

- Hydrogen Alarm Sensors (45-AE-002/3)
- Moisture Indicators / Leak Detectors (46-LS-001, 47-LS-001)

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3.10.1 PRIMARY EQUIPMENT

The safety equipment system is comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2051
- 1001757-2000-PID-PP-2052
- 1001757-2000-PID-PP-2053
- 1001757-2000-PID-PP-2054
- 1001757-2000-PID-PP-2055
- 1001757-2000-PID-PP-2058

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.10.2 PROCESS OBJECTIVES

The objective of the safety equipment is to ensure safe operation, prevent personal injuries and avoid the risk of explosion.

3.10.3 SYSTEM DESCRIPTION

3.10.3.1 Hydrogen Alarm sensors

Hydrogen gas will also be produced during the electrolytic reaction which produces the diluted sodium hypochlorite solution; therefore, to mitigate any explosion and health risks the level of the hydrogen in the surrounding of the electrolytic reactors will be continuously monitored using two ATEX rated hydrogen alarm sensors (45-AE-002/3) in duty/standby configuration. The hydrogen alarm sensors will be fitted at the highest point of the building ceiling. If the level of hydrogen in the atmosphere is above the defined level, an audible and visible alarm (45-AAH-002/3) will be triggered to alert the operator for the evacuation of the building.

3.10.3.2 Moisture Indicator / Leak Detector

3.10.3.2.1 Sodium Hypochlorite Storage Tanks

The sodium hypochlorite storage tanks will be within a collecting basin to limit the spreading of the sodium hypochlorite solution in case of leakage and/or spillage. The collecting basin will be fitted with the moisture indicator/leak detector (46-LS-001) to monitor the occurrence of leakage and/or spillage. In case of leakage and/or spillage, an audio alarm will be triggered to alert the operator, and the sodium hypochlorite generator will automatically be closed. Inspection will then be conducted by the operator to identify the leaking area and/or spilling cause.

3.10.3.2.2 Calcium Hypochlorite Storage Tanks

The calcium hypochlorite storage tanks will be housed in a collecting basin to limit the spread of the calcium hypochlorite solution in case of leakage and/or spillage. The collecting basin will be fitted with the moisture indicator/leak detector (47-LS-001) to monitor the occurrence of leakage and/or spillage. In case of leakage and/or spillage, an audio alarm will be triggered to alert the operator and the actuated valve on the service water feed stream (47-XV-001) will automatically be closed. Inspection will then be conducted by the operator to identify the leaking area and/or spilling cause.

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3.11 LIFTING EQUIPMENT

The lifting equipment system consists of the following systems:

- Overhead Travelling Crane
- Service water pumps electrical gantry crane
- Fire water pumps electrical gantry cranes

3.11.1 PRIMARY EQUIPMENT

The lifting equipment system is comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2050
- 1001757-2000-PID-PP-2061

This equipment shall be monitored, controlled, and protected by the control system with controls and statuses displayed on the operator interfaces.

3.11.2 PROCESS OBJECTIVES

The objective of the lifting equipment is to lift and transport any load between zero and the test load. Additionally, all lifting equipment will be capable of traversing the full operating footprint of the sodium hypochlorite generation plant whilst holding the loads in a safe and accessible way. The lifting equipment test load will also be permanently displayed. All travel movements will be free of snatching, shuddering, and crabbing over its full travel distance.

3.11.3 SYSTEM DESCRIPTION

3.11.3.1 Overhead Travelling Crane

The overhead travelling crane will be capable of offloading the salt bags during delivery and replenishing the salt bags into the salt dissolution tanks during operation. The overhead travelling crane will be accessible, easy to operate and control by the operator and serviced easily. A maintenance platform will be provided for the travelling crane.

All three directions of travel, namely hook or lifting direction, cross travel, and long travel directions, will be electrically powered by motors with a minimum of two speeds. The drives required for these motors will preferably be electronic variable speed drives to assist in the control of slowing down the motors. Starting and stopping will be smooth. Inching capability will be provided for all three directions of travel. Both long and cross travel will revert to low speed prior to contact with the end stops.

A control pendant will be accessible to the operator and used to control the hook travel, cross travel, and long travel of the crane. The pendant will move independently along the length of the crane beam and will hang to one metre above the loading bay floor level.

3.11.3.2 Service water pumps electrical gantry crane

The lifting equipment in the service water pump room will be capable of offloading the pumps during delivery and removing the pumps for maintenance requirements. The lifting equipment will consist of a fixed gantry and a motorised trolley. The crane will be accessible, easy to operate and control by the operator and serviced easily.

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3.11.3.3 Fire water pumps electrical gantry cranes

The lifting equipment in the service water pump room will be capable of offloading the pumps during delivery and removing the pumps for maintenance requirements. The lifting equipment will consist of a fixed gantry and a motorised trolley. The crane will be accessible, easy to operate and control by the operator and serviced easily.

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4. CONTROL NARRATIVE – BULK CONVEYANCE

4.1 RESERVOIR LEVEL MEASUREMENT

The reservoir level measurement system will include the following units:

- Radar Water Level Sensor (84-LI-003)
- Ultrasonic Water Level Sensor (84-LI-004)

4.1.1 PRIMARY EQUIPMENT

The reservoir level sensors is captured in the following P&IDs:

- 1001757-2000-PID-PP-2062

This equipment shall be monitored, controlled, and protected by the control system with the controls and status displayed on the operator interfaces.

4.1.2 PROCESS OBJECTIVES

The objective of the reservoir level sensors is to measure the water level (WL) of the Muldersvlei reservoir.

4.1.3 SYSTEM DESCRIPTION

The radar water level sensor (84-LI-003) will be the primary sensor, with the ultrasonic water level sensor (84-LI-004) as the secondary. The ultrasonic sensor will be a backup in the event of a signal loss from the radar sensor. It can also be used to verify the measurement from the primary radar sensor, as a difference between the two readings would indicate a measurement issue.

4.2 ACTUATED INLET VALVE

The actuated inlet valve system will include the following units:

- DN1600 Actuated Butterfly Isolation valve (84-XV-001)
- Radar Water Level Sensor (84-LI-003)
- Ultrasonic Water Level Sensor (84-LI-004)

4.2.1 PRIMARY EQUIPMENT

The actuated inlet valves are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2062

This equipment shall be monitored, controlled, and protected by the control system with the controls and status displayed on the operator interfaces.

4.2.2 PROCESS OBJECTIVES

The objective of the actuated inlet valve is to prevent the Muldersvlei Reservoir from overflowing by isolating the supply from Wemmershoek Water Treatment Plant (WTP).

4.2.3 SYSTEM DESCRIPTION

When a preset high water level (HWL) is detected in the reservoir by the level sensor (84-LI-003), an alarm will sound and the operator will have the option of closing this valve remotely and to stop the supply. If the water level reaches a preset high-high water level

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(HHWL), the actuated isolation valve (84-XV-001) will close automatically. Water from Wemmershoek WTP will thus bypass the Muldersvlei Reservoir offtake and flow directly to Glen Garry reservoir. After the actuated valve has been shut and the water in the reservoir has dropped to a preset operating level, the operator will need to open the valve to allow supply from Wemmershoek WTP to flow into the reservoir, i.e. the valve shall not open automatically.

4.3 ACTUATED OUTLET CONTROL VALVE

The outlet control valve system will include the following units:

- Two DN1200 Electronically Actuated Needle Control Valves. (84-FCV-001 & 84-FCV-002)
- DN1200 Flow Meter (84-FT-002)

4.3.1 PRIMARY EQUIPMENT

The actuated inlet valves are comprised of equipment that is captured in the following P&IDs:

- 1001757-2000-PID-PP-2063

This equipment shall be monitored, controlled and protected by the control system with the controls and status displayed on the operator interfaces.

4.3.2 PROCESS OBJECTIVES

The objective of the actuated outlet needle valves is to control the outflow from Muldersvlei Reservoir to Glen Garry Reservoir.

4.3.3 SYSTEM DESCRIPTION

The two needle valves (84-FCV-001 & 84-FCV-002) will control the outflow from Muldersvlei Reservoir. An operator will select an outflow quantity (e.g., 150 Mℓ/d), which will then result in one of two things:

- if the flow meter (84-FT-002) measures an outflow lower than this amount, both control valves will increase their opening percentages by a preset value (e.g., 1%) until the flow meter measures the flow rate selected by the operator.

- if the flow meter (84-FT-002) measures an outflow higher than this amount, both control valves will decrease their opening percentages by a preset value (e.g., 1%) until the flow meter measures the flow rate selected by the operator.

The valves will be sized to operate within the manufacturers continuous operating range e.g., 80 % and 20 %. A higher percentage open will result in higher outflows, while a lower percentage will result in lower outflows. Both valves will open and close by the same percentage when operating together. The flow range for this system will be between 50 Mℓ/d and 220 Mℓ/d.

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5. CONCLUSION

The control narrative described provides the process control of the Muldersvlei Reservoir to meet process design and operational requirements. This is done to ensure that the treated water meets the South African drinking water regulatory requirement stipulated by the Department of Water and Sanitation.

It shall be the responsibility of the Contractor to provide a detailed control philosophy as well as the operation and maintenance manual of the individual mechanical equipment. These shall be reviewed and approved by the Engineer.

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3.7.5 PARTICULAR SPECIFICATIONS

The following Particular Specifications, as listed below, shall apply to this contract, complete with any corrections and amendments applicable at the time of tendering. Amendments to the Particular Specifications are bound in the contract document in C3.7.6: Detailed Civil and Pipeline Specifications, C3.7.7 Detailed Mechanical Specifications, C3.7.8: Detailed Electrical Specifications, and C3.7.9 Detailed Electronic Specifications.

Title	Description	Pages
	CCT Standard specification for design – build of mechanical equipment	109
	CCT Standard specifications for electrical works	141
W&S-EAM-PROC-002	Plant Numbering System SAP Plant Maintenance	50
W&S-BW01	Standard specification for double flanged butterfly valves for inline use on trunk mains	12
W&S-BW010	Standard specification for mechanical type straight couplings, stepped couplings and flange adaptors	4
W&S-BW015	Standard specification for gate valves	4
W&S-BW016	Standard specification for electromagnetic flow meters	3
SPE-JJ-0003	General corrosion protection for pipelines, water and waste water works	68
SPE-MP-7001	Design and Manufacture of Medium-Pressure Steel Specials	17
SPE-MP-7002	Manufacture of Medium-Pressure Steel Pipelines	17
SPE-CC-7003	Laying and jointing of medium-pressure steel pipes specials	27
SPE-MM-7022	Air valve for air release and vacuum break on pipelines	5
SPE-MP-7024	Pipe supports	4
SPE-MM-7030	Plunger valves	8
SPE-CC-0001	Fencing	5
SPE-CC-0002	Dry Laid Concrete Block Retaining Wall	4
SPE-CC-0003	Design, selection and installation of HDPE dam liners	4
SPE-GG-0001	Geotechnical Geosynthetics	9
SPE-GG-0002	Soil Nails	13
SPE-GG-0003	Shotcrete	20
SPE-GG-0004	Monitoring	12
SPE-MM-0001	HVAC specification	63
SPE-WW-0001	Irrigation	16
Spec EL	Site Laboratory	8
Spec GF	Grid Flooring	7
Spec PD	Building Work	27
Spec PZ	Repairs to STR Concrete	11
Spec SL	Soft Landscaping	16
SPE-FI-0001	Wet Fire Specification	41
SPE-FI-0002	Fire Stopping Specification	8
Spec 2221528-AppD	AC Mitigation Infrastructure	15
		748

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Making progress possible. Together.

STANDARD SPECIFICATION
FOR
DESIGN – BUILD
OF
MECHANICAL EQUIPMENT

DIRECTORATE:

WATER AND WASTE

DEPARTMENT:

WATER AND SANITATION

SECTION D (CIDB 3 volume FIDIC contract)

Recent input	Approved by	Date Approved
Engineering and Asset Management **Reticulation** **Waste Water** **Bulk Water** **Environmental**	[redacted] **ENGINEERING AND ASSET MANAGEMENT**	August 2020
	[redacted] **ENGINEERING AND ASSET MANAGEMENT**	August 2020

[redacted]

Revision History:

Version 2020

No.	Existing Sections UPDATED	Summary of updates
D1 To D58	Overhaul of entire document	Paragraph Re-Number and sequence changes Verify reference Standards Group similar type of equipment
No.	Section Heading ADDED	
D40	Mechanical Screen	

Version 2016

No.	Heading UPDATED	Summary of updates
	Machine Vibration	Heading change to Condition Monitoring
	Condition Monitoring	Thermography and Oil Sampling added
	Pump Performance Testing	Factory Performance Testing to meet ISO 9906 Grade 1 On-site Performance Testing to meet ISO 9906 Grade 3
	Operating Instructions and Signage	Fasteners specified and drawings available on request
	O&M Manuals	Electronic formats to be supplied on USB Flash Disk
	Standard Drawings	Updated Steel Access Door drawings
	Quality Control Procedures	Various additional QCP's available on request

Version 2015

No.	Heading UPDATED	Summary of updates
	Grid Flooring	GRP detail added with anti-slip surface required as standard
	Pipework for Pump Suction	SS316 segmented bell-mouth design requirements added
	Penstocks	Various additions as well as QCP
	Machine Vibration	Condition Monitoring Portable Verification additional section
	Training	Heading change from Tuition
	O&M Manuals	Various changes (nametag details and photo required)
	Defects Notification Period	Maintenance capturing format
	Heading ADDED	
	Standard Drawings	Various standard design drawings are available on request
	Quality Control Procedures	Various QCP's are available on request

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D1. RELEVANCE AND PURPOSE

The Standard Specification for Mechanical Works shall apply wherever it is relevant to the Contract unless it is superseded in accordance with the precedence stated and, in particular, by the Detailed Mechanical Specification.

In the case of discrepancies between various City Specifications the variance shall be brought to the Engineers attention for clarification.

D2. DESIGN

D2.1. General Design

This Specification lays down the performance, quality and overall system requirements of the Works. Deviation from the Specification will only be considered if the Engineer considers such deviation an improvement.

D2.2. Climatic Conditions (CAPE PENINSULA)

The following climatic conditions shall be minimum specification to comply with for equipment design. Sites shall be considered as coastal.

Barometric Pressure	101,3kPa
Summer Conditions	
dry bulb temperature	
Max General Areas	36°C
Max Voelvlei / Gouda	43°C
Average 24 Hr	22°C
wet bulb temperature, max.	23°C
Relative Humidity	20-30%
Wind Direction	Predominantly South to South East
Max. hourly average	36 knots (67 km/h)
Gusts up to	74 knots (137 km/h)
Winter Conditions	
dry bulb temperature -min	0°C
Relative Humidity - max	100%
Wet Bulb Temp - Min	0°C
Wind Direction	Predominantly North to North West
Max. hourly average	40 knots (74 km/h)
Gusts up to	68 knots (126 km/h)

Wastewater Treatment Works

For the purposes of this Specification all Wastewater Treatment Works shall be regarded as severe marine environments.

Besides being coastal, treatment works have large open liquid areas which are aerated and/or agitated and the environment is damp. The high prevailing winds can also carry spray and foam not only from the plant but in some areas also from the sea.

This environment is very corrosive to ferrous metals and, where the use of such metals cannot be avoided, the metals must be adequately protected,

Sewage gas is also present throughout the treatment works and this may contain hydrogen sulphide which, in addition to being corrosive to ferrous metal, is also corrosive to most

[redacted]

non-ferrous metals. **The effect on copper alloys can be particularly severe, often with disastrous effects on the reliability and life of switchgear, control systems, slip-rings, etc. Such equipment must therefore be adequately sealed and protected.**

D2.3. Drawings

General and detailed fabrication drawings shall be submitted by the Contractor for approval by the Engineer.

The drawings shall comply with the following:

(a) Drawings shall be provided in electronic data of AutoCAD format or compactable version indicating the true reflection of as built design.

(b) Drawings shall be prepared in accordance with the latest issue of SANS 10111. The equivalent BS code of engineering drawing practice will also be acceptable.

(c) Manufacturing Drawings shall be suitable size for clear large print, A4, A3, A2 is acceptable.

(d) For large equipment and site installation Drawings shall be to A1 or A0 size.

(e) Drawings shall be to scale, with both the scale and the drawing being large enough to clearly show all relevant components of the plant and equipment.

(f) In addition to the usual plan and two side elevations, sufficient additional sections shall be included to clearly show the arrangement of all plant and equipment.

(g) Item lists shall be provided on the drawing or on a separate parts list.

(h) Item descriptions shall include the material of construction, quantity and full identification information, including, as applicable, brand name, manufacturer's reference number, model number, size, rating, source, duty, quantity, etc.

(i) Full details of the welding procedures and standards shall be shown on drawings.

(j) Process Flow Diagrams (PFDs) & Piping and Instrumentation Diagrams(P&IDs) shall be included in the drawing sets for installations involving piping systems.

D2.4. Safety in design

Safety shall be an all-important and overriding consideration and proper attention shall be paid to this aspect at the design stage. The regulations of the Occupational Health and Safety Act, Act 85 of 1993, as amended, shall be strictly complied with.

Equipment which is potentially dangerous in terms of explosion, injury to people, damage to equipment, chemical hazardous, negative impact on the environment shall be designed in accordance with a relevant South African or international Standard.

The following rules shall be implemented:

(a) Hazards must be avoided or guarded. Nip points shall be guarded; sharp corners shall be rounded off; operating handles, supports and protrusions shall be kept clear of access ways.

(b) The Design Drawings and specifications shall clearly specify the structural requirements of the Works and the Contractor shall be responsible for covering all unsafe gaps and openings left in structures after installation.

(c) Moving parts shall be properly guarded to the satisfaction of the Engineer.

D2.5. Design Life

All equipment shall have a minimum life of 100 000 running hours or 15 years (whichever is first) before major part repair or replacement is required;

Bearings shall be designed for an L10 life exceeding 100 000 hours.

Ball and roller bearings shall generally be selected for a design life of 100 000 – 200 000 hours; i.e. the bearing manufacturer's category for machines required to work with a high degree of reliability 24 hours per day.

Design, fabrication and the assessment of design life shall be in accordance with BS 5400, as applicable.

Appropriate de-rating factors shall be applied to suit the application.

[redacted]

If the material used has insufficient resistance to solar radiation (U.V. light) for the application, suitable protection must be provided to achieve the required life.

D2.6. Design Aspects

High quality standard shall be implemented with reliable, trouble free operation, efficiency, ease of maintenance and operation, and neatness are essential.

All plant and equipment shall be of robust construction and the design shall be based on:

(a) the full range of duties which can be reasonably anticipated;

(b) the power and torque transmitted by the driver system under full load and stalled conditions;

(c) the maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits;

(d) conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers;

(e) engineering sound safety factors will be implemented for the relevant application;

(f) where continuous twenty-four hours per day operation is specified; duty/standby arrangement shall apply;

(g) design shall include prevention of serious damage to equipment from normal operational: preventing blockages, blinding, jamming, seizure, malfunction.

(h) Stainless steel and 3CR12 shall be constructed, fabricated and erected in accordance with SANS 10162 - Part 4: The design of cold-formed stainless steel structural members.

D2.7. Fail-Safe Operation and Protections

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems must be designed to be fail to safety in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse, by:

- built-in redundant elements,

  or

- must return to a safe condition where no further damage can be done

All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high risk situations, must be incorporated.

Protections shall:

(a) be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage (electrical thermal type overloads are inadequate);

(b) stop or prevent from starting all equipment at risk;

(c) activate an alarm with a labelled indicator on the control panel whenever a protection operates;

(d) not permit unauthorised tampering;

(e) operate reliably after long inactive periods exposed to corrosive and dirty conditions.

Design shall clearly indicate equipment limitations which can be exceeded during operation and which cannot be guarded against.

D2.8. Moving Parts

The following general requirements apply not only to machines but to all equipment with moving parts such as headstocks, extension spindles, swivelling davits, heavy duty hinges, pivots:

(a) All rotating or swivelling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.

(b) Swivelling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks.

(c) On abrasive applications abrasion resistant materials and slow speed operation shall be utilised. Raw sewage and sludge shall be regarded as very abrasive.

[redacted]

(d) All applications associated with wastewater shall be regarded as corrosive and materials of construction shall be selected to suit.

(e) Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures.

(f) in areas of fluctuating stresses, the use of welded components shall be avoided.

(g) The locking of nuts and pins in position shall be done to the approval of the Engineer.

(h) Wearing parts shall be designed for interchangeability and ease of removal and replacement.

D2.9. Arrangement and Mounting

The arrangement and general design shall take the following requirements into consideration:

(a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

(b) Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.

(c) Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.

(d) Equipment and installation will comply with best practices for operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal.

(e) With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified in the Design Drawings.

D2.10. Prevention of Corrosion

The Contractor shall review all designs from a corrosion protection point of view prior to commencing work. Any details which might have a negative effect on the corrosion protection and the future application of coatings are to be brought to the Engineer's attention for a ruling prior to commencement of work.

All items shall be designed to minimize corrosion in the environment in which they shall be exposed. Particular emphasis shall be placed on accessibility for surface preparation and the application of coatings. The requirements of SANS 10120 – 3 HC shall apply.

Mastics, sealants, insertion rubber or suitable gasket material shall be used to seal unavoidable crevices such as bolted connections; e.g. under guardrail feet.

The design shall ensure that surfaces of corrodible materials, such as carbon steel, shall be accessible for initial coating and for maintenance. The use of back-to-back angles, partially open box sections or inaccessible stiffeners shall be avoided. Fabrication openings shall be of sufficient size to enable fettling, blast cleaning and painting.

D2.11. Steel Pipework – Design

Pipework up to DN 600 shall be in accordance with SANS 1476. Pipework for the conveyance of water shall, in addition, comply with CCT-WS-BW Standard Specification for Steel Pipe, Fittings and Specials.

D3. MATERIALS

D3.1. Materials – General

All materials used in the manufacture and construction of plant and equipment shall be new, unused and shall be the best of their respective kinds. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and the extremely corrosive environment.

D3.2. Steel

All structural steel shall comply with the requirements of SANS 1431 grade 300W / 1465 / 1200H and shall be legibly marked with the maker's name or trade mark and identification marks.

Steelwork shall be constructed, fabricated and erected in accordance with SABS Standard

[redacted]

Building Regulations, Chapter 6, "Structural Steelwork", and with SANS 1200 H, 10160, 10162.

D3.3. Stainless steel

The AISI grade (or SA equivalent) of stainless steel to be used will normally be specified in the Detailed Mechanical Specification. Unless otherwise specified, rolled material shall be supplied with a matt, annealed and pickled or otherwise de-scaled surface finish.

For wrought steels, the equivalent BS 970 grade shall be used.

The following material selection shall apply, unless specified in the detailed specification:

APPLICATION	AISI	BS 970
Wastewater Treatment Works (all applications)		
Welded	316L	316S12
Not welded	316	316S16
Low Corrosion Interior		
Welded	304L	304S12
Not Welded	304	304S15
Exterior and Corrosive Interior		
Welded	316L	316S12
Not Welded	316	316S16

A manufacturer's test certificate shall be provided for each batch of stainless steel giving details of the material analysis and any mechanical tests carried out on the material. Each stainless steel item supplied shall be clearly and permanently marked with the grade of stainless steel and cross-referenced to the applicable test certificate.

D3.4. 3CR12

3CR12 is titanium stabilised, 12% chrome steel as produced by Columbus Stainless, South Africa.

3CR12 shall always be supplied with an annealed and pickled finish.

3CR12 shall be suitably abrasive blasted to ensure adhesion of the prime coat to the metal surface.

D3.5. Plastics

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

D3.6. Castings

Castings shall comply with the relevant South Africa or British Standard for the material used, including the following:

Grey Cast Iron	SANS 1034	BS 1452
Sand Casting Iron	SANS 936/7	BS 2789
Steel (General Purpose)	SANS 1465	BS 3100
Aluminium	SANS 989/992	BS 1490
Copper and Copper Alloy	SANS 200	BS 1400

Particular attention shall be paid to cleanliness, soundness and neat fettling and dressing of castings. Surfaces shall be smooth and free from irregularities. The presence of porosity, sand and slag inclusions will not be tolerated. Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area. Sufficient space shall be provided for the use of ring or socket spanners.

[redacted]

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

No repairs shall be undertaken to castings without the written permission of the Engineer and **welding will not be permitted on cast iron castings.**

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular, stainless steel castings shall be heat treated to ensure that all carbides are in solution. This also provides optimum grain size, and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron. This certificate must include details of the material analysis, the heat treatment and any mechanical tests carried out.

D4. FABRICATION OF STEEL

D4.1. Welding

D4.1.1. Standards

All welds shall comply with SANS 10044 – WELDING.

All welding consumables shall comply with SANS 2001-CS1

Welding workmanship shall comply with SANS 2001-CS1 – Section 4.4.

Welders, welding operators and tack welders shall be qualified by a fabricator, steelwork erector or an independent testing agency, in accordance with the provisions of ANSI/AWS D1.1/D1.1M.

D4.1.2. Continuous Welding and Elimination of Crevices

Where the design requires continuous weld on all sides of any joint: All crevices, including those arising from welding on one side only, shall be eliminated.

In special cases, non-continuous welding might be approved in writing by the Engineer. The resulting crevices shall be sealed with either a coal tar product which can be applied at thicknesses of up to 1 mm such as Carboline Bitumastic 50 or equivalent; or a two-part solvent free epoxy which can be applied at thicknesses of up to 600 µm such as Sigmaline 523 or equivalent.

D4.1.3. Weld Appearance

Welding shall be free of blowholes, projections, pinholes, splatter and undercuts and all welding flux shall be removed. All weld spatter and other sharp imperfections shall be removed prior to abrasive blasting. Prior to painting, weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground. Weld grinding must not be performed on 304L or 316L stainless steel, unless unavoidable and in approval by the Engineer.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro-cleaning as approved by the Engineer but should rather be avoided by taking the appropriate measures.

D4.1.4. Site Welding

Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

D4.1.5. Stainless Steel Welding

Stainless steels shall be welded strictly as recommended in "The Stainless Steel User Manual" issued by Columbus Stainless.

3CR12 shall be welded strictly as recommended in "The 3CR12 Fabrication Guide" issued by Columbus Stainless.

D4.1.6. Stainless Steel Type

Austenitic stainless steels to be welded shall be of the low carbon grade (i.e.: 304L, 316L, etc.).

D4.1.7. Welding Rods

[redacted]

The welding rods used shall be the most suitable for the metal and purpose. Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing.

D4.1.8. Welders

Only welders experienced with suitable qualification shall be acceptable welding stainless materials.

D4.2. Stainless Steel

The following requirements apply to the fabrication of stainless steels:

(a) Fabrication of stainless steels and 3CR12 shall follow the recommendations in "The Stainless Steel User Manual" and "The 3CR12 Fabrication Guide" issued by Columbus Stainless.

(b) Only experienced stainless steel fabricators shall be considered acceptable.

(c) Fabricators shall use permanently dedicated storage and fabrication areas and shall use machines, tools and handling equipment suited and permanently dedicated for stainless steel.

(d) Surfaces which become contaminated with steel or stained or marked showing uneven colour, shall be cleaned by pickling or electro-cleaning.

D4.3. Surface Finish

Edges shall be rounded to a radius of at least 2 mm.

Weld spatter and other protrusions shall be removed.

D4.4. Factory Acceptance Inspection

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop prior to corrosion protection.

D5. CORROSION PROTECTION

D5.1. Application and Control

D5.1.1. Factory Painting Contractor

Surface preparation and coating application shall be carried out by suitably trained and experienced industrial painting contractors who are fully equipped and staffed to do such work in their own covered premises strictly in accordance with the paint manufacturer's recommendations.

Before proceeding with the corrosion protection coatings, the Contractor shall submit the name of the painting sub-contractor and the proposed works supervisor for approval by the Engineer.

D5.1.2. Coating Systems/Steps

The corrosion protection systems to be used on the plant and equipment will usually be specified in the Detailed Mechanical Specification, but if not, the Contractor shall recommend a suitable system for approval by the Engineer. If doubt exists as to the system or colour to be used, the Engineer's requirements must be ascertained.

Alternative coating systems that is superior to those specified may be used if approved in writing by the Engineer.

Except where otherwise specified, all metal surfaces shall be painted. This includes hot-dip galvanized items and metal-sprayed coatings. In the latter case the paint shall be in the form of a sealer.

D5.1.3. Painting of Stainless Steel

Items made of 316 or 316L stainless steel may be left unpainted provided the surface is of uniform self-colour without blemishes, rust, marks or stains.

If blemished, the surfaces must either be painted or cleaned by pickling and/or electro-cleaning (not grinding or other mechanical means).

If corrosion of 316 stainless steel does occur, and depending on the appearance or extent of the problem, the Engineer may call for pickling, electro-cleaning, painting or replacement of the item.

[redacted]

Painting may be required if contaminated or stained surfaces cannot be properly cleaned or where stitch welding has been approved.

D5.1.4. Quality Control of Coating Application

The Contractor shall provide a Quality Plan which shall include all steps in the surface preparation and corrosion protection process plus technical data sheets for all products proposed.

Records of compliance with the Quality Plan shall be maintained.

A written report of the inspections, prepared by the Inspector and signed by both the Inspector and the Contractor, shall be submitted for appraisal by the Engineer before delivery of the equipment to Site.

D5.1.5. Responsibility and Rectification

The Contractor is responsible for the quality of the work and materials used, irrespective of any quality surveillance that may be carried out by the Engineer.

If unacceptable work is found on Site, the full unacceptable area identified by the engineer shall be redone after the Contractor has submitted a method proposal.

D5.1.6. Inspections

The Contractor shall arrange for the inspection by the Engineer at every stage of the coating application. The Engineer may approve inspections by an independent competent person appointed by and at the cost of the Contractor.

Inspections shall be adequate to ensure compliance with the Specification and shall be done at the following stages as a minimum:

Coating (Hot-Metal Spray, Paint, etc.)
After surface preparation but before application of the first coat.
After application of the paint primer or first coat.
After application of the final coating
After the final factory applied paint or sealing coat.

Hot-dip Galvanizing
After fabrication but before hot-dip galvanizing.
After hot-dip galvanizing.

Duplex Protection (Hot-dip Galvanizing and Coating)
After fabrication but before hot-dip galvanizing.
After hot-dip galvanizing but before application of the first coat.
After application of the primer.
After the final Site-applied paint coat.

If the coating is to be done in the Cape Peninsula by in inspector other than the Engineer, the Contractor shall, nevertheless, arrange for the Engineer to witness the inspections at the latter's discretion.

D5.1.7. Dry Film Thickness

The dry film thickness (dft) of any coat or coating system shall be determined in accordance with SANS 2808. The test method defines that the instrument is to be calibrated on a substrate that represents the surface to be coated.

The dry film thickness shall be measured using a non-destructive thickness testing machine and shall comply with the Specification. 90 % of all thicknesses measured shall comply with the minimum requirements of the Specification. Up to 10 % of all readings may be below the specified minimum thickness, but may not be less than 80 % of the specified minimum thickness.

The dry film thickness given in microns and, except where otherwise specified, is the minimum (not average) thickness permissible.

D5.1.8. Inspector Qualifications

Inspectors appointed by the Contractor shall hold an appropriate qualification from one of the following:

(a) Corrosion Institute of Southern Africa.

(b) South African Institute of Welding.

[redacted]

(c) South African Institute for Non-Destructive Testing.

(d) South African Qualification and Certification Committee.

D5.1.9. Identification of Items

Every item to be coated shall be identified by a welded or hard-stamped code. Records shall be maintained for each item.

D5.2. Surface Preparation

D5.2.1. Cleanliness

The provision of acceptable cleanliness entails the removal of:

- mill scale
- coatings and/or corrosion product
- surface contaminants such as oil, grease and soluble salts.

Water soluble salts present on the steel before application of the primer shall not exceed 10 µg/cm^2.

All surfaces which have been machined or have had holes drilled shall be regarded as having oil and grease contamination.

D5.2.2. Abrasive Blasting

Before coating, all new steel surfaces shall be abrasive blast cleaned in accordance with Section 4.3 of SANS 10064 to a preparation grade of ISO-Sa3 in accordance with ISO 8501. The blast profile, measured in accordance with SANS 5772 (dial gauge), shall be in the range of 50 to 75 µm. The abrasive shall comply with SANS 10064 and shall be free from all traces of oil, grease, foreign matter and corrosive contaminants such as chlorides, etc. The blasted surface shall be cleaned and degreased as required. The prepared surface shall be given the first coat of the painting system within 4 hours after blasting.

In instances where stainless steel and 3CR12 are to be painted, the surface shall be suitably abrasive blasted prior to primer application.

D5.2.3. Between Coats

Between coats or with previously painted surfaces in good condition, all traces of oils, greases, soluble salts and corrosive air borne contaminants shall be thoroughly washed from the surface to be painted using a detergent type cleaning agent, rinsed and dried. The previous coat shall then immediately be lightly sanded or otherwise prepared as recommended by the paint manufacturer, wiped clean, dried and painted. Solvents are not acceptable as a surface cleaning agent.

D5.2.4. Hot-Dip Galvanized Surfaces

Hot-dip galvanized surfaces to be painted shall not be passivated and shall be free from white rust and shall be cleaned with an approved water based galvanizing cleaner using non-metallic abrasive pads until a "water break free" surface is obtained. The surface shall then be thoroughly rinsed with clean potable water to remove all residues and dried immediately prior to painting. Where necessary to obtain adhesion a sweep blast of the surface shall be done after cleaning.

D5.3. Metal Coatings And Duplex Coatings

D5.3.1. Standards

Fabrication of items to be protected by metal coatings shall be in accordance with SANS 14713.

D5.3.2. Hot-Dip Galvanizing

D5.3.2.1. General

Hot-dip galvanizing shall be done in accordance with SANS 121 and the following shall apply:

(a) Coatings shall be to the thickness detailed in the Standard.

(b) Hot-dip galvanized material which is to remain unpainted shall be passivated as specified in SANS 121.

(c) Items to be painted after hot-dip galvanizing shall be air dried and not passivated.

(d) Stacking and storing shall at all times be done in a manner to prevent white rust forming.

[redacted]

(e) Damage to hot-dip galvanizing caused by welding, grinding is not acceptable.

(f) Repair to hot-dip galvanizing damaged by handling or transport shall be done by cleaning the area and applying 3 coats of a zinc rich primer giving a dry film thickness of at least 100 µm and containing at least 94 % zinc in the dried film.

(g) Welding after hot-dip galvanizing is not acceptable.

(h) The Contractor shall supply a galvanizer's guarantee or test certificate prior to installation.

D5.3.2.2. Duplex Systems

Preparation and application of organic coatings on hot-dip galvanizing shall be done in accordance with the Hot Dip Galvanizers Association Southern Africa's Code of Practice for Surface Preparation and Application of Organic Coatings.

The duplex system shall be as follows:

(a) Hot-dip galvanizing; without passivation of the zinc coating.

(b) Application of one coat of an epoxy primer (two part; for hot-dip galvanised surfaces) with a dft of 75 µm.

(c) Polyurethane enamel top coat (two part) with a dft of 50 µm; done on Site after suitable repair to the primer.

D5.3.2.3. Hot-Metal Sprayed Coatings

General

Fabrication and surface preparation of items to be protected by hot-metal spray shall comply with the requirements specified in this Standard Specification for Mechanical Works (including General Works).

Hot-metal sprayed coatings shall be in accordance with SANS 2063 and shall comply with the following:

(a) The minimum coating thickness for both aluminium and zinc shall be 150 µm. Greater thicknesses may be specified in the Detailed Mechanical Specification.

(b) The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles. Angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes. The minus tolerance on thickness in isolated areas shall also not exceed –10 % and such low areas shall not be larger than 50 mm in diameter.

(c) The time between surface preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

(d) Unless otherwise specified, all hot-metal coatings shall be sealed and coated immediately after hot-metal spraying. The system shall consist of a low viscosity sealant, which is applied until absorption is complete, followed by a suitable coating system.

The sealant systems outlined below are acceptable (where appropriate for the particular application).

System 1 (for immersion applications)

Application of an epoxy zinc sealer to a dft of 60 µm (Sigmacover 522, or equivalent).

Application of two coats of epoxy pipe coating to a dft (per coat) of 125 µm; (Sigmaguard 720, or equivalent).

System 2 (for non-immersion applications)

Application of a two part epoxy primer to a dry film thickness of 40 µm; (Intergard 269, Carboline Rustbond Penetrating Sealer, or equivalent).

Application of one intermediate coat chemical resistant vinyl copolymer to a minimum dry film thickness of 70 µm (Carboline Polyclad 938 HB, or equivalent).

Application of one coat of vinyl copolymer chemical resistant enamel to a minimum dry film thickness of 40 µm (Carboline Polyclad 938-2, or equivalent).



System 3 (suitable for crane beams, gantries, etc.)

Application of one coat of a two-part epoxy primer to a dry film thickness of 40 µm; (Carboline Rustbond Penetrating Sealer, Intergard 269, or equivalent).

Application of two coats of a two-part polyurethane enamel (two part) to a minimum combined dry film thickness of 70 µm.

System 4

Application of micaceous oxide pigmented polyamide cured epoxy to achieve a dry film thickness of 60-80 µm; (Sigmacover 522, or equivalent).

One coat of solvent borne modified acrylic coating to achieve a dry film thickness of 70 µm; (Sigma Topacryl coating, or equivalent).

One coat of solvent borne modified acrylic finish to a dry film thickness of 30-45 µm; (Sigma Topacryl finish, or equivalent).

D5.4. Paint Coatings

D5.4.1. Paint Quality

Paint shall be of best quality, of approved manufacture and brand and comply with the requirements of the relevant SANS (South African National Standards) or BS specifications.

Urethane based paint is to be used for concrete surfaces

Traffic paint is to be used for tarred surfaces

D5.4.2. Compatibility

All materials in a paint system shall be purchased from one paint manufacturer.

D5.4.3. Packaging

All coating materials shall be delivered in the manufacturer's original, sealed containers of maximum 25 litre capacity, clearly marked with the following:

(a) Manufacturer's name.

(b) Product Brand and Reference Number.

(c) Batch Number, which may incorporate the date of manufacture.

(d) Date of manufacture, unless already incorporated in the batch number.

(e) instructions for storage

(f) Instructions for use of the material, including:

- mixing ratios of components for multi-component materials
- minimum temperature of application,
- method of application,
- minimum and maximum overcoating times.

D5.4.4. Confirmation of Suitability

Contractors shall obtain confirmation from their paint suppliers that, when using their paints, the systems specified are technically correct and suitable for the application and the material being coated.

D5.4.5. Paint Application

D5.4.5.1. Environmental Conditions

Paint shall not be applied if:

(g) the conditions are windy or dusty.

(h) the surface temperature is less than 10 °C.

(i) the surface temperature is less than 3 °C above dewpoint.

(j) the surface temperature is above 35 °C.

(k) the conditions are contrary to the manufacturer's recommendations.



(l) the relative humidity is 85% or above (the determination of humidity may be made using moisture sensitive hair-type gauges, electronic gauges or sling psychrometers (whirling hygrometers) having a resolution of at least 1% humidity. Electronic gauges shall have calibration certification not more than 6 months old. Moisture sensitive hair-type and analogue gauges shall have a calibration certificate not more than 1 month old. The accuracy of thermometer used in sling psychrometers shall be tested by placing at least 4 thermometers displaying temperatures within half a degree Centigrade of a mean shall be used).

D5.4.5.2. Mixing

Coating materials shall be mixed thoroughly by a power stirrer.

In the case of two-pack materials, each component shall be thoroughly stirred separately. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. The use of part of the contents is not acceptable.

In the case of solvent based epoxy materials, the mixed material shall be allowed to stand for the induction period recommended by the material manufacturer.

D5.4.5.3. Painting

Paints shall be applied strictly in accordance with the manufacturer's instructions by tradesmen skilled in this class of work. Thinning of paint shall only be allowed for spray application and the manufacturer's recommended thinners shall be used.

D5.4.5.4. Stripe Coats

All edges and welds shall be provided with at least one stripe coat. This coat shall, preferably, be the same as the primer but can be the same as the intermediate coat.

D5.4.5.5. Coating of Hidden Areas

Areas which will be inaccessible after erection and surfaces resting on floors shall receive the full paint system prior to erection.

D5.4.5.6. Surfaces in Contact

Mating or contact surfaces shall be treated with one of the following systems, the system being chosen to suit the application:

(a) Surfaces shall be prepared and primed and brought together while the paint is still wet; or,

(b) Each surface shall be provided with one coat of inorganic zinc silicate; or,

(c) Surfaces shall be provided with a mastic or sealant; or,

(d) Surfaces shall be provided with insertion rubber or other gasket material.

D5.4.5.7. Crevices

Crevices will not be permitted. Where unavoidable crevices are accepted by the Engineer, such crevices shall be sealed with either a coal tar product which can be applied at thicknesses of up to 1 000 µm such as Carboline Bitumastic 50 or equivalent; or a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm such as Sigmaline 523 or equivalent.

D5.4.5.8. Items Encased in Concrete

Metal to be encased in concrete shall be painted externally up to 30 mm inside the concrete section, leaving the remainder bare so as to facilitate bonding with the concrete.

D5.4.5.9. Protection of Machined Surfaces

Where painting of machined surfaces is not possible or advisable, these surfaces shall be coated with an approved proprietary anti-corrosion compound giving 12 months protection under operating conditions. Shaft ends and machined mating or mounting surfaces or pads shall be so coated and shall not be painted.

D5.4.6. Site Work

Surface preparation and coating application shall not be done on Site except for minor repairs, for application of the final aesthetic coat, where specifically called for in the Detailed Mechanical Specification or where permitted by the Engineer in writing.

[redacted]

D5.4.6.1. Repair

Painted areas damaged during transportation, erection or any means whatever shall be repaired as follows:

Rusted spots shall be removed and cleaned by means of a wire brush or emery paper to a bright metal finish and the surrounding paint which is still intact shall be feathered for a distance of 50 mm beyond the damaged area.

Spot priming and repair shall consist of all the coats previously applied and shall overlap the undamaged area.

D5.4.6.2. Protection on Site

Proper and adequate use of cover sheets and other means shall be made to protect the existing paintwork from damage and from metal dust and sparks when welding, grinding, and wire brushing on site. Similarly, effective steps shall be taken to prevent spillage or splashing or other damage to floors, walls and equipment when painting on site and any damage or mess caused shall be corrected at the Contractor's cost.

D5.5. Painting Systems/Steps

D5.5.1. Immersed Steel Fabrications

This system is suitable for steel items subject to immersion, semi-immersion and non-immersion such as tanks, pipes, etc.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Apply three coats of a low solvent, high solids,polyamine/amide cured, epoxy (two part).	350
		Total = 350 µm
The coating shall undergo EID detection over the full surface in accordance with SANS 1217. This test shall be done by an inspector holding an appropriate qualification from either the CISA, the SAIW or the SAQCC. When applied to hot-dip galvanized surfaces, a suitable epoxy primer shall be used after careful surface preparation before applying this system. This system shall be applied by a specialist applicator prior to delivery to site with particular attention to the required interval between coats. The first and third coats shall be a different colour to the second coat.		

D5.5.2. Immersed Steel Fabrications (non-chalking surface)

This system has similar applications to the system above but which also require a non-chalking surface.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	System for Large Immersed Steel Fabrications	350
2	One coat of polyurethane enamel (two part)	40
		Total = 390 µm

D5.5.3. Immersed Steel Fabrications (not requiring decorative finish)

This system is suitable for steel items subject to immersion, semi-immersion and non-immersion such as archimedes screw pumps, large tanks, etc.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	

[redacted]

2	Coat of polyamine/amide cured coal tar epoxy.	140
3	Coat of polyamine/amide cured coal tar epoxy.	140
4	Coat of polyamine/amide cured coal tar epoxy.	140
		Total = 420 µm
Each coat shall preferably be of a different colour. Two coats will be acceptable if recommended by the paint manufacturer.		

D5.5.4. Non-immersed Steel in Coastal Atmosphere

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Coat of two component zinc epoxy primer.	100
3	Coat of two component epoxy intermediate.	150
4	Coat of polyurethane enamel (two part).	50
		Total = 300 µm

D5.5.5. Non-Immersed Steel in Moderate Atmosphere

This system is suitable for heavy fabricated steel items requiring a hard, high gloss colour finish; eg. bridges, structural steel, mobile equipment, etc.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Coat of inorganic zinc silicate	75
3	Coat of epoxy intermediate coat	75
4	Coat of polyurethane enamel (two part)	40
		Total = 190 µm
The complete system must be factory applied and touch ups will be required on Site. The primer shall be tested for full cure before applying the subsequent coats. This system shall not be used for items subject to immersion.		

D5.5.6. Hot-Dip Galvanized Steel (Duplex)

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	After hot-dip galvanizing, do not passivate.	
2	Coat epoxy primer (two part for HDG surfaces)	75
3	Coat polyurethane enamel (two part)	50
		Total = 125 µm

D5.5.7. Repair to Coating on Steel and Cast Iron

This system is suitable as a maintenance coat over weathered coatings and partially failed coatings.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)

[redacted]

1	Surface preparation shall include, as a minimum, removal of all loose mill scale, non-adherent rust and loose paint prior to wire brushing and de-greasing and shall comply with ISO-St3 (ISO 8501) or with SSPC-SP3 (Steel Structures Painting Council of the USA).	
2	Coat of aluminium filled epoxy (two part).	100
3	Coat of epoxy intermediate.	150
4	Coat of polyurethane enamel (two part).	40
		Total = 290 µm

D5.5.8. Cast Iron Components

This system is suitable for motors, gearboxes and other cast iron components.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa21/2 in accordance with ISO 8501	
2	Coat high build epoxy primer	100
3	Coat polyurethane enamel (two part)	60
		Total = 160 µm

D5.5.9. Steel in Dry Applications up to 200 °C

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Coat of a two part micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (Sigmacover 522 or equivalent).	60
3	Coat of a two part micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (Sigmacover 522 or equivalent).	60
		Total = 120 µm

D5.5.10. Steel in Dry Applications up to 200 °C

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501.	
2	Coat of inorganic zinc silicate.	75
3	Coat of modified silicon heat resisting coating for 200 °C.	75
		Total = 150 µm

Particular care shall be taken to obtain the recommended anchor pattern during abrasive blasting and to achieve the required primer thickness on all surfaces in one coat.

The primer must be factory applied.

The primer shall be tested for full cure before applying the subsequent coat.

An intermediate coat suitable for 200 °C shall be included between the primer and top coat if so recommended by the paint manufacturer.

The top coat must cure at ambient temperatures.

To [redacted]

D5.5.11. Steel in Potable Water up to 100 °C

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Coat of a two part micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (Sigmacover 522 or equivalent).	80
3	Coat of a two part micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (Sigmacover 522 or equivalent).	80
4	Coat of a two part micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (Sigmacover 522 or equivalent).	80
		Total = 240 µm

D5.5.12. Steel and Cast Iron in Dry Applications up to 540 °C

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Coat modified silicon	40
3	Coat modified silicon	40
4	Coat modified silicon	40
		Total = 120 µm

D5.5.13. Steel Grid Flooring (where HDG is not suitable)

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa21/2 in accordance with ISO 8501.	
2	Apply a glass flake resin by dipping in catalysed resin.	

D5.5.14. Fusion Bonded Epoxy

This system is suitable for immersed objects, cast iron valve bodies, pipework, etc.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Apply fusion bonded epoxy in accordance with the manufacturer's instructions for the item to be coated.	300
		Total = 300 µm
This is a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating in accordance with SANS 1217. The material used shall be of Type 2; i.e. a thermosetting powder-coating material. Pre-heating is needed to achieve the required coating thickness. No reading shall be less than 200 µm. The Contractor shall execute EID detection over the full surface in accordance with		

[redacted]

SANS 1217. The items to be coated shall be prepared in accordance with the relevant clauses of this Specification and, in particular, shall have edges ground to a radius of curvature of at least 3 mm.

D5.5.15. Hot-Applied Thermoplastic

This system is suitable for immersed objects, cast iron valve bodies, pipework, etc.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Blast steel surface to ISO-Sa3 in accordance with ISO 8501	
2	Apply one coat of a synthetic thermoplastic polyamide.	300
		Total = 300 µm
No reading shall be less than 200 µm. The coating shall be applied by dipping into a fluidised bed of the polymer after the object has been suitably heated. The coating shall be executed strictly in accordance with the recommendations of the polymer supplier and the applicator shall be certified by the supplier for application of the coating. The Contractor shall execute EID detection over the full surface in accordance with SANS 1217. Objects to be coated shall be prepared in accordance with the relevant clauses of this Specification and, in particular, shall have edges ground to a radius of curvature of at least 3 mm.		

D5.5.16. Repair of Coatings on Submerged Steelwork

This is a two part, solvent free epoxy which is suitable for application to wet steel.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Abrade corroded areas to St 2 in accordance with ISO 8501.	
2	Feather existing coating and lightly abrade existing coating.	
3	Clean and degrease surfaces to be coated and allow to dry.	
4	Apply coat(s) of a two part, solvent free epoxy which is suitable for application to wet steel.	800
		Total = 800 µm
Coating shall be done in accordance with the manufacturer's instructions.		

D5.5.17. Provide Thick Coating for Complex Surfaces

These systems are thick coatings for covering complex surfaces normally including crevices which are formed by fasteners, seams, edges and corners and are generally applied either before or after the parent surfaces have already been suitably coated. Suitable for immersed and non-immersed applications.

STEP	PREPARATION/COATING METHOD	Minimum dft (µm)
1	Clean and degrease surfaces to be coated and allow to dry.	

[redacted]

2a	Two coats of a solvent free, two part epoxy which can be applied at thicknesses of up to 600 µm such as Sigmaline 523 or equivalent.	600
	OR	
2b	Single part, cold applied coal tar coating which can be applied up to a dry film thickness not less than 1 000 µm; Carboline Bitumastic 50 or equivalent.	1 000
		Total > 1 000

D5.6. Acceptable Materials and Suppliers

The table below lists acceptable materials and suppliers. In all cases, other equivalent materials and suppliers are acceptable.

GENERIC	MATERIAL/SUPPLIER
Hot-Dip Galvanizing	Hot-dip galvanisers shall hold the certification mark for SANS 121.
Powder Coating	Plascon epoxy/polyester powder : CEP series, Sigmalining FBE 27.
Universal Undercoat	Sigmarine 40, Carboline GP-64 Undercoat, Plascon Plasconamel 189 Undercoat.
High-Gloss Alkyd Enamel	Carboline AD-51 Finish, Plasconamel 1000 Finish, Sigmarine 49.
HB Epoxy Primer : Two Part	Plascon Plascotuff HB Epoxy MLE series, Sigmazinc 109HS, Carboline 193 Primer.
Epoxy Primer : Two Part (for hot-dip galvanized surfaces)	International Interguard 269, Sigmacover 280.
Polyamine/Amide Cured Epoxy Sealer/Coating : Two Part	Carboline Rustbond Penetrating Sealer, Plascon Plascoguard Copon EA3 Primer, Sigmacover 522.
Epoxy Intermediate Coat	Sigmacover 456, Carboline 190 HB, Plascon Plascosafe 18 Primer, Sigmacover 435.
Low Solvent, High Solids, Polyamine/Amide Cured Epoxy : Two Part	Plascon Plascoguard Copon KSIR88, Sigmaguard 720 Ameron Amercoat 385, Carboline 891.
Polyamine/amide Cured Coal Tar Epoxy : Two Part	Sigmacover 300, Carbomastic 200, Ameron Amercoat 78HBB.
Solvent Free Epoxy repair coating	Plascon Plascoguard Copon Hycote 151, Sigmaguard 575.
Aluminium Filled Epoxy : Two Part	Ameron Amerlock 400 AL, Carbomastic 15, Sigmacover 630.
Two Part Solvent Free Epoxy For Submerged Applications	Sigmarite Submarine Coating, Carboline 1208, InterZone 954, Jotamastic 87.
Zinc Phosphate Primer	Carboline GP-18 Primer, Plascon Plascoprime 183 HB, Bildphos M10 Primer.
Inorganic Zinc Silicate	Plascon Plascozinc 233, Sigmazinc 160, Carboline Carbozinc 11, Ameron Dimetcote 11.
Modified Silicon	Carboline 4631, Plascon Plascotherm Silicone 540 – Aluminium, Sigmatherm 520.

[redacted]

Silicone Acrylic	Plascon Plascotherm Silicon – Acrylic 200 T, Carboline 1248.
Polyurethane Enamel : Two Part	Sigmadur 550, Carboline 134 over polyamine/mide coatings, Carboline 133 HB over zinc coatings, International Interthane 990, Plascon Plascothane Recoatable Enamel CPC Series, for two-coat systems, Plascon Plascothane Recoatable Enamel CPQ Series, for single coat systems.
Glass Flake Resin	Power Blast Vitaglass or equivalent.
Hot-applied Thermoplastic	Rilsan or equivalent.
Thick Coating for Complex Surfaces	Sigmaline 523 or Carboline Bitumastic 50.

D5.7. Colour Code

Colours shall comply with the National Colour Standard, SANS 1091.

The final colour marking shall be in accordance with SANS 10140.

Where SANS 10140 does not specify a requirement, the colour marking shall comply with the following:

PIPEWORK				
CONTENTS OF PIPE	BASIC COLOUR	COLOUR OF INDICATOR		
		1 BAND	2BANDS	3 BANDS
AIR				
Compressed Air	Arctic Blue (F28)			
Ventilation Air	Pale Grey (G62)			
Aeration	Arctic Blue (F28)	Canary Yellow (C61)		
Instrument	Arctic Blue (F28)	Salmon Pink (A40)		
Vacuum	Arctic Blue (F28)	Primrose (C67)		
Lime Transfer	Arctic Blue (F28)	Crimson (A03)		
Backwash	Arctic Blue (F28)	Verdigris Green (E22)		
CHEMICALS				
Aluminium Sulphate	Jacaranda (F18)	Verdigris Green (E22)	-	-
Sodium Aluminate	Jacaranda (F18)	Crimson (A03)	-	-
Ferric Sulphate	Jacaranda (F18)	Canary Yellow (C61)	-	-

[redacted]

Lime (dry powder)	Jacaranda (F18)	Salmon Pink (A40)	-	-
Activated Carbon	Jacaranda (F18)	Light Stone (C37)	-	-
Polyelectrolyte	Jacaranda (F18)	Cloud White (G80)	-	-
WWPolyelectrolyte	Aquamarine (E67)	Dark Violet (F06)		
GASSES (other than air); liquefied or gaseous				
Butane, Propane	Light Stone (C37)	-	-	-
Ammonia	Light Stone (C37)	Ultramarine (F09)	-	-
Blast furnace	Light Stone (C37)	Crimson (A03)	-	-
Carbon Dioxide	Light Stone (C37)	Light Brunswick Green (H07)	-	-
Coke Oven	Light Stone (C37)	Light Grey (G29)	-	-
Producer	Light Stone (C37)	Verdigris Green (E22)	-	-
Chlorine, Hypochlorite	Light Stone (C37)	Canary Yellow (C61)	-	-
WWChlorine, Hypochlorite	Canary Yellow (C61)			
Oxygen	Cloud White (G80)			
Digester Gas	Smoke Grey (F20)			
Steam	Silver (Aluminium)			
Hydrogen	Poppy Red (A14)			
WATER				
Cold Drinkable	Brilliant Green (H10)	Cornflower (F29)	-	-
Hot Drinkable	Brilliant Green (H10)	Crimson (A03)	Cornflower (F29)	-
WWFresh Water	Cornflower (F29)			
Boiler Feed (Distilled)	Brilliant Green (H10)	Crimson (A03)	Cloud White (G80)	Crimson (A03)
Boiler Feed (De-mineralised)	Brilliant Green (H10)	Cloud White (G80)	-	-

[redacted]

Industrial, Raw	Brilliant Green (H10)	Golden Yellow (B49)	-	-
Reclaimed	Brilliant Green (H10)	Jacaranda (F18)	-	-
Backwash	Brilliant Green (H10)	Light Stone (C37)	-	-
De-sludge	Brilliant Green (H10)	Canary Yellow (C61)	-	-
Stove Circulating	Brilliant Green (H10)	Salmon Pink (A40)	-	-
Hydraulic Power	Brilliant Green (H10)	Terra Cotta (A10)	-	-
Final Treated Effluent	Aquamarine (E67)	-	-	-
WWCooling Water	Aquamarine (E67)			
Interchange, Stage	Drakensberg Green (H36)	-	-	-
Raw Sewage	Olive Green (H05)	-	-	-
WWRaw Sewage	Light Olive Green (H21)			
Sea Water	Light Brunswick Green (H07)	-	-	-
Primary Sludge	Dark Brown (B03)	-	-	-
Waste Activated Sludge	Light Brown (B15)	-	-	-
Digested Sludge	Light Brown (B15)	Light Olive Green (H21)	-	-
Pasteurised Sludge	Light Brown (B15)	Cloud White (G80)	-	-
OIL				
Diesel Fuel	Golden Brown (B13)	Cloud White (G80)	-	-
WWDiesel Fuel	Golden Brown (B13)			
Hydraulic Power	Golden Brown (B13)	Salmon Pink (A40)	-	-
WWHydraulic Oil	Salmon Pink (A40)			
Lubricating	Golden Brown (B13)	Verdigris Green (E22)	-	-

[redacted]

WWLubricating Oil	Verdigris Green (E22)			
Transformer	Golden Brown (B13)	Crimson (A03)	-	-
Paraffin	Golden Brown (B13)	Arctic Blue (F28)	-	-
OTHER LIQUIDS				
Scour Pipes		Deep Buff	(B24)	
WWDrainage	Black			

MARKINGS; ARROWS / BANDS	
WWDirection arrows, Unit no., etc.	Black on white, White on other colours.
WWBands shall be 250 mm wide, 4 000 mm apart.	
WWHot liquid lines shall have a 50 mm wide band of Crimson (A03) every 4 000 mm.	

PLANT AND EQUIPMENT	COLOUR NAME	COLOUR CODE
FIRE FIGHTING: Equipment and Pipework	Signal Red	(A11)
MECHANICAL EQUIPMENT (WW)		
Pumps	To suit liquid being pumped.	
Blowers, Compressors, incl. ancillary equipment	Strong Blue (F11)	
Turning shafts, Couplings, Pulleys, Fans, etc.	Light Orange (B26)	
Baseplates	Black	
Valves	To suit liquid being handled. Basic colour of pipeline	
Handwheels	Black	
Bridges for settling tanks	Light Admiralty Grey (E46), or Arctic Blue (F28)	
Bulk mechanical equipment, Gearboxes, General Fabrications, Brackets, Supports	Light Grey (G29)	
Cranes and Crawl Beams	Golden Yellow (B49)	
ELECTRICAL		
Distribution Boards Switch-Gear Terminal Boxes Conduits	Light Orange	(B26)
Emergency stop control stop devices	Signal Red	(A11)
Motors : External	Light Grey (G29) (RAL7035)	
Motors : Fans, Cowl internal surfaces	Light Orange (B26) (RAL2000).	
MACHINE GUARDS		
Inside Guards : Internal surfaces	Light Orange	(B26)

[redacted]

Outside Guards : External surfaces	Colour of Machine As per adjacent surfaces, but always contrasting with B26	
Protruding OR Turning Shafts, Exposed Gear Wheels Rotating Parts, Couplings, Pulleys, fans	Light Orange	(B26)
HANDRAILS		
Guardrails :Horizontal Rails and Chains	Golden Yellow	(B49)
Guardrails :Stanchions	Black	
Guardrails : Bottom horizontal	Black	
Protrusion, Sides of Ramps, Low beams	Black and Yellow Diagonal Stripes	(- /B49)
WORKSHOP FLOOR DEMARCATION		
Demarcation Lines	Golden Yellow	(B49)
Working Areas	Pastel Grey	(G54)
No Parking, No Storage	Golden Yellow	(B49)
Aisles and Walkways	Brilliant Green	(H10)
Storage Area	Terracotta	(A10)

Note: WW = specifically applicable to Waste Water works

D6. INSTALLATION

D6.1. Installation – General

The Works shall comply with the following:

(a) When installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

(b) The Contractor shall provide all foundation bolts, supports, hangers, brackets, required for the support and fixing of equipment.

(c) The use of more than three shims in the alignment of equipment will not be permitted. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.

(d) Corrosion protection - All mating faces must be coated before assembly.

(e) Nickel-based, anti-seize compound shall be applied along the full length of SS fastener threads before the nut is applied.

(f) Where crevices are formed between two metal surfaces that need to be sealed, shall be filled with a suitable formable packing, Denso tape or equivalent, or with a suitable mastic or sealant, prior to final fastening.

(g) Hot-dip galvanized material shall be free from white rust when it is erected on site.

D6.2. Alignment of Shafts

Alignment of drives and driven shafts, shall:

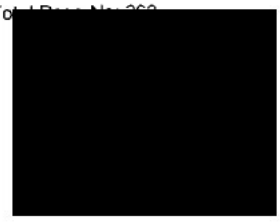
(h) be done after installation and before commissioning and shall be checked in the presence and to the approval of the Engineer.

(i) be sufficiently accurate to ensure that no initial pre-load is placed on the shaft coupling.

(j) done by specialists using laser aligning equipment with real time computer display.

(k) use Epocast 36, Chockfast or equivalent for pourable epoxy resin chocks.

(l) for pourable chocks each machine foot shall be provided with a screw for vertical alignment.



(m) the chock thickness not be less than 20 mm.

D7. FASTENERS

D7.1. Standards

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series. Allen head screws of any type shall not be used without the Engineer's written consent.

D7.2. Fasteners Material

All fasteners M12 and smaller shall be of grade 316 SS, or better.

All fasteners in corrosive areas shall be of 316 SS, or better.

Corrosive areas shall be taken to include any moist or wet area such as in and above settling tanks, in or in the vicinity of open channels, where a continuous spray can be expected and all internal and external areas in the vicinity of the inlet works of a wastewater treatment works.

All fasteners embedded in brick, concrete or soil shall also be of 316 SS, or better.

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

Where high tensile bolts are required by the design, they shall be hot-dip or electro galvanized. The bolt holes and crevices shall be filled and sealed prior to painting.

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. 316 SS bolts must be used to fasten together 316 stainless steel fabrications or flanges.

D7.3. Washers

Washers of similar material to the bolts shall be provided under each nut and setscrew head. Multiple washers or shims shall not be used. Spring washers or other approved locking arrangement shall be used on all fasteners subject to vibration.

D7.4. Anti-Seize Compound

Before assembly, threads shall be treated with a nickel based, anti-seize/corrosion protection compound; Chesterton 725: Nickel Anti-Seize Compound, or equivalent. The Contractor shall implement the following procedures:

(a) Copper-based compounds are not acceptable and, if used, shall be cleaned off before the correct compound is applied.

(b) If it is found during inspection that the compound has not been applied, the Contractor shall disassemble all fasteners and comply with this requirement.

(c) A small amount of compound shall be applied along the full length of the thread before the nut is applied. Excessive compound visible on the thread after the nut has been applied shall be cleaned off.

D7.5. Thread Projection

All bolt shanks shall protrude beyond the end of the nut by at least 1.5x thread pitch after tightening.

D7.6. Corrosion Protection

After installation the exposed surfaces of bolts not made of 316 SS or of EN 1.4162 shall be coated a similar colour as the items being fastened.

If the use of Allen head or similar fasteners has been approved by the Engineer, the recessed heads shall be filled with a suitable non-hardening sealing compound.

D7.7. Anchor Fasteners

D7.7.1. Type and Material

All anchor fasteners shall be of grade 316 SS, or better.

Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Anchor fasteners for other applications may be of the expanding type or chemical



anchor type.

D7.7.2. Hook Bolts

Grade 316 SS, or better, hook bolts shall be supplied and grouted by the Contractor into pockets which will be provided in the concrete structure in accordance with the information to be supplied by the Contractor. The grouting products shall be used strictly in accordance with the manufacturer's instructions.

D7.7.3. Alternative Anchor Bolts

The use of 316 stainless steel "Hilti Kwik Bolt" stud bolts or equivalent may be used as an alternative where approved by the Engineer. If steel reinforcing bars are encountered while the holes are being drilled, the Contractor shall knock a hole in the concrete around the steel and grout in a stainless steel hook bolt as described above.

D7.7.4. Through-Bolt Anchors

Machinery anchored by studs or bolts that extend through the supporting structure, shall be fastened down with the use of nuts from both sides. The studs and associated nuts, washers and brackets, shall be of grade 316 SS, or better.

D8. ELEVATED WALKWAYS

All platforms and stairways shall be constructed with a non-slip profile or finish.

Consideration may be given to use glass reinforced plastic (GRP) grating only in applications of non-elevated heights and where theft is a potential problem. The grating shall be of open grating type and not less than 38mm in depth. The mesh size shall not be less than 38mm x 38mm and the resin shall be Vinyl Ester.

All elevated walkways and stairways shall be Mild Steel hot-Dip Galvanized construction.

The depth of bearer bars in steel grid flooring shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm. The bearer bars shall be across the shorter span.

Panels shall be set level and fixed to angle frames to prevent rocking.

Cut-outs in grid flooring for pipes, valve spindles, etc. are to be made and banded before any corrosion protection is done. The edges of removable grid access covers must also be banded.

Grid flooring and frames shall be hot-dip galvanized after fabrication. Alternatively, a glass flake resin which is applied by dipping the flooring in catalysed resin, is acceptable; such as Power Blast's Vitaglass or equivalent. The grating shall be of open grating type and not less than 38mm in depth. The mesh size shall not be less than 38mm x 38mm and the resin shall be Vinyl Ester. All GRP type grating shall include an anti-slip coating. Painted coatings will not be acceptable.

Where grid flooring rests on painted surfaces, strips of rubber insertion material shall be secured under the grid to protect the paint.

The fixing clip set (saddle clamp and locking plate) shall be of hot-dip galvanised steel or stainless steel. All fasteners shall be of grade 316 SS, or better.

D9. GUARD RAILING

D9.1. General

Guard railing shall be provided in accordance with legislated requirements and shall be provided generally in locations where the vertical change in level is 1 m or greater.

Guard railing shall comply with SANS 10104.

D9.2. Guard Railing for Equipment Installations

Guard railing for equipment installations shall comply with the following specific requirements: Guard railing shall be of grade 316 stainless steel or hot-dipped galvanized mild steel depending on the corrosion severity of the environment.

(a) Guard rails shall include hand and knee rails not less than 32 mm diameter and stanchions spaced at not more than 1,8 m apart except where specifically directed otherwise in writing by the Engineer.

(b) On platforms, walkways, landings or around dangerous areas the vertical height,

[redacted]

measured from the top of the hand rail to the floor or surface, shall be **at least 1 m**.

(c) On stairways and fixed ladders the rails shall be parallel to the strings, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

(d) For applications covered by this Specification, the rails and stanchion shall withstand, without permanent deflection, a proof force of 890 N and 1780 N respectively, applied at any point and in any direction. This requirement is in addition to any strength requirement specified in SANS 10104. Contractors shall provide proof that their guard railing has been tested and withstands these loads.

(e) No opening between rails shall allow the passage of a ball of diameter 600 mm.

(f) Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded or sheared off.

(g) Welded guard rail installations are preferred. Installations which incorporate jointed sections shall be secure and without relative movement of the components under loading. "Pop" riveted installations will not be acceptable.

(h) Butt weld Joints: All horizontal hand-railing joints shall incorporate 360 degree full butt welds such that a uniform / laminar joint is the nett result. Joints shall be smoothly finished, without corners. Butt Welding may be administered in a phased approach to minimise distortion. The welds shall be neat & require no grinding for ergonomically use.

(i) Carbon Steel HDG ball stanchion hand-railing: The ball stanchion and pipe interphase, shall have a full continuous weld 280 degrees leaving an 80 degree gap at the bottom for water drainage.

(j) Stainless Steel 304L and 316L ball stanchion hand-railing: The ball stanchion and pipe interphase shall have a 60 degree full continuous weld top and bottom. The welds shall preferably be TIG welded to minimise heat induction and can be applied in a phased approach to minimize heat distortion.

(k) Railings shall be ended off with positively fixed closure bends. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically designed for such a position shall be employed. No sharp endings will be permitted.

(l) Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction. Welding shall be continuous and shall be smoothly finished and then passivated.

(m) Stanchions which are hollow shall be self-draining.

(n) Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm X 8 mm. Two fasteners, of minimum size M16, shall be used to secure each foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under stanchion feet to prevent the formation of crevices.

(o) Stanchion feet which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 mm X 10 mm. In instances where the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated on at least two surfaces. Four fasteners, of minimum size M16, shall be used to anchor the foot. Non-shrink, cementitious grout shall be applied under the foot just prior to final tightening of nuts.

(p) All components shall be supplied in the pickled and passivated condition which may also be polished. All surfaces must be uncontaminated and unmarked to ensure maximum corrosion resistance. A manufacturer's test certificate shall be provided for each batch of stainless steel giving the chemical analysis of the material.

(q) Where kick-plates are required by legislation, these shall extend to 100 mm above the walkway level.

D10. PERMANENT LADDERS AND STAIRS

D10.1. General

Permanent ladders shall comply, primarily, with the requirements of the OSH Act and,

secondarily, with SANS 50131 Stairs shall comply with SANS 10400, Part M.

Unless other materials are specified, ladders and stairs shall be of carbon steel and hot-dip galvanized after all fabrication has been completed.

Unless other materials are specified, bolts shall be hot-dip galvanised but anchor bolts in concrete and brickwork shall be of grade 316 SS, or better, and shall be no smaller than M16.

D10.2. Permanent Ladders

Ladders shall comply with the following detail design aspects:

(a) Access points to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

(b) No part of the ladders shall project into the passageway.

(c) The width between strings shall be between 380 mm and 450 mm.

(d) A minimum clear space of 150 mm must be allowed behind the rungs away from the structure to which the ladder is attached

(e) The diameter of the rungs shall be approximately 25 mm and these shall be formed from HT steel reinforcing bar.

(f) Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap between the platform and the ladder. Sufficient rungs shall be provided to ensure a maximum gap of 75 mm. These top rungs shall be at the same level as the floor or platform to which access is being provided.

(g) Strings shall be formed from flat bar.

(h) The vertical distance between the ladder support brackets shall not exceed 1 800 mm.

(i) The strings shall extend to 900 mm above the floor or platform and shall be matched with any guard rail protections at this level. Connections between hot-dip galvanized steel ladders and stainless steel guard railing shall be bolted. Unless laterally supported by the guard rails, these strings shall be supported by vertical structural sections (not flat bar) whose footings shall comply with this Specification for guard rail stanchion feet.

(j) All rises in a flight shall be uniform and the surface of the top rung shall be level with the top platform or landing. The height chosen for the rise shall be between 225 mm and 255 mm.

(k) If the height between start and end levels is over 5 m, the ladder shall be fitted with a safety cage. The safety cage shall extend at least 900 mm above the higher landing. The cage *"shall afford firm support along its whole length for the back of the person climbing the ladder, and for which purpose no part of the cage shall be more than 700 mm away from the level of the rungs." (as per OHS General Safety Regulations)*. The cage shall comprise no fewer than seven vertical elements.

(l) Resting platforms will be installed every 8m.

(m) Strings, rungs and support members shall be of solid structural sections (e.g. flat bar, round bar, square bar, angles, etc.) and no hollow sections will be accepted for any part of the ladder.

D10.3. Stairs

(n) Handrails shall be provided on both sides of the stairway, unless the stairway consists of 3 or less treads/steps.

(o) Stair treads shall be manufactured from 38mm x 38mm non-slip mesh grating. The grating must be manufactured to the criteria set out under the 'Grid Flooring' section of this specification.

(p) The raise of steps shall not exceed 200mm.

(q) The horizontal displacement between the nosing (edge of a step) of each succeeding tread shall be 250 mm or greater.

(r) The depth/breadth of each tread shall be 250mm or greater.

(s) Each tread shall overlap the next lower tread by not less than 25mm.

(t) The width of the stair treads may not be less than 750mm.

[redacted]

(u) The dimension of each step of the stairway shall be calculated as follows:

(v) Displacement between succeeding tread nosing + Tread riser distance (x2) = 570mm > 650mm.

(w) The angle of inclination shall not exceed 41.5 degrees.

(x) The vertical height, measured from the front tread edge to the ceiling, must not be less than 2100mm at any point of the stairway.

(y) Stairway landings, which serve two flights in a continuous straight line, shall have a minimum length of 900mm and a width equal to or greater than the width of the flights.

(z) No flight of stairs shall have a vertical rise greater than 3000mm between landings.

(aa) No door shall open onto a stairway unless such door opens onto a landing and the width of such landing is not less than that of such door. The position of the door relative to the landing and its direction of opening shall be such that it does not obstruct the flow of persons on the stairway when in the fully open position.

(bb) All fasteners shall be High Tensile Mild Steel, class 8.8 electro galvanised bolts accompanied with suitable nuts and washers of the same material.

(cc) A base plate shall be welded to the base of each stringer. The base plates will be used to chemically anchor the stairs onto a reinforced concrete plinth with 4 x M12 grade 316 stainless steel bolts.

D11. PIPEWORK

D11.1. Pipe Standards

D11.1.1. Steel Pipe – General Duties

Steel pipes for general non-corrosive, non-abrasive duties for liquid, air and gas shall be as follows:

Up to DN 150	-	SANS 62 medium class.
Over DN 150	-	SANS 719.

Unless otherwise specified, steel pipework and fittings shall be hot-dip galvanised and painted.

D11.1.2. Stainless Steel Pipework

Stainless steel pipework shall be to ASTM 312. Schedule 10 pipes and fittings shall be used except where otherwise specified.

D11.1.3. Steam Pipework

Steam pipework smaller than DN 50 shall be of 316 stainless steel to ASTM A-312 Schedule 40 or approved equal. Steam pipework DN 50 and larger shall be manufactured to SANS 62 heavy class, ANSI B36.10 STD/Schedule 40 or to BS 1600 Schedule 40. Steel pipework shall be supplied with a suitable temporary corrosion protection both internally and externally in order to prevent corrosion during the storage, installation and pre-commissioning period. A primer similar to Plascon SNK 2, phenolic modified polyvinyl butyral self-etch primer, would be suitable.

D11.1.4. Hydraulic and Oil Pipework

Hydraulic pipework shall be to BS 778 or equal. All hydraulic and oil pipes and fittings shall be thoroughly degreased, descaled and cleaned internally and externally after fabrication by abrasive blasting or pickling, thoroughly cleaned and rinsed, dipped in a hot iron phosphate solution and coated internally with a corrosion inhibiting, oil soluble preservative. After treatment and drying all openings shall be sealed until the pipes are installed.

D11.1.5. Butt Weld Pipe Fittings

Steel butt welding pipe fittings shall be to ANSI B 16.9, BS 1965 or BS 1640 of the same schedule as the pipework or heavier. Butt weld fittings in stainless steel shall be to ASA B 36.19 for schedule 5S and 10S and ASA B 16.9 for schedule 40S and 80S. Alternatively, fittings may be to BS 1640.

If the use of a loose hot-dip galvanized butt flange arrangement with stainless steel pipework is specified or approved by the Engineer, such arrangement and design shall comply with BS 4504 Table 6/6 or 10/6 as appropriate. The butt welded shouldered end for the pipe may be rolled from

[redacted]

hot rolled stainless steel angle section. The hot-dip galvanized butt flange must be electrically insulated from the stainless steel pipework.

D11.1.6. Malleable Cast Iron

Malleable cast iron fittings shall be to SANS 14.

D11.1.7. Cast Iron

Cast iron pipes and fittings shall comply with BS 2035 (Class D) and shall be pressure tested in accordance with Clause 12 of that Standard. The requirements of the Standard with regard to protection and flanges shall be modified to comply with this Specification. Also refer to Clause "Castings" of this Specification.

D11.1.8. Copper

Copper pipes shall be to BS 2871 or SANS equivalent.

D11.1.9. Plastic Pipework

Polyethylene or Polypropylene pipes shall comply with SANS 533 and SANS 1315 respectively and shall carry the SABS mark. The contractor manufacturing and installing the pipework shall satisfy the requirements of SANS 9001. PVC pipework is not acceptable except where specified.

D11.2. Pipework Design

D11.2.1. Pipe Type and Material

The type and material of pipe to be used will be given in the Detailed Mechanical Specification.

D11.2.2. Pipe Diameters

Unless otherwise specified in the Detailed Mechanical Specification, pipe diameters shall be based on the following velocities. The velocities shall be based on the compressed volume at the operating pressure in the case of steam, air and other gases. Valves and other ancillaries shall generally be of the same nominal diameter as the pipe. Non-standard sizes shall not be used.

FLUID	FLUID FLOW [ℓ/s]			
	0-2,5	2,5-15	15-100	100-500
	ALLOWABLE FLOW VELOCITY [m/s]			
LIQUID				
GRIT FREE:	0.75 max	1,25 max	1,5 max	2 max
HIGH SOLIDS OR GRIT:		0,8 min	1 min	1 min
		1,5 max	1,75 max	2 max
STEAM	10 max	15 max	20 max	25 max
AIR AND GAS				
above 10 kPa	5 max	8 max	10 max	12 max
below 10 kPa	2,5 max	3 max	4 max	5 max

D11.2.3. Coupling Arrangement

Screwed fittings may be used on DN 50 and smaller provided that sufficient unions or flanges are provided for disassembly and removal of equipment. Reducing sockets and reducing bushes shall be used where required.

All steel pipes larger than DN 50 shall be flanged or fitted with mechanical pipe couplings as applicable.

Suitable pipe couplings shall be incorporated wherever necessary to facilitate maintenance or isolate vibration. A coupling shall be provided on each pump suction. Couplings shall be

[redacted]

adequately restrained by harnesses as specified in the Clause "Pipe Couplings".

D11.2.4. Draining, Venting and Purging

On liquid lines provision shall be made for draining and venting where necessary. Vents shall be provided at all vertical down bends on gravity lines. On gas lines provision shall be made for purging.

D11.2.5. Condensate Drains for Air Lines

Automatic condensate traps with isolating valves and valved by-passes shall be provided at all necessary points including ahead of any globe type valve, orifice plate or concentric reducer in a horizontal line, at each change of level and immediately ahead of the user equipment.

A suitable well of a diameter equal to the pipe diameter with a bottom drain shall be provided at each condensate removal point. Condensate traps and valves shall be accessible and condensate shall be piped to the nearest drain. Pipework shall be sloped in the direction of flow towards a drain point with a slope of 1 in 150 and care shall be taken to avoid sagging at any point.

D11.2.6. By-Passes

Isolating valves and valved by-passes shall be provided around condensate traps, pressure reducing valves and valves with solenoid or other actuation which do not have provision for manual operation.

D11.2.7. Encased Pipes

Pipework to be permanently encased in concrete, cement or similar shall be of cast iron or 316 SS, or better, for steel and stainless steel pipework respectively. The encased portion shall be a short, straight length of pipe, flanged both ends with adequate clearance between the wall surface and the flanges for inserting flange bolts. Victaulic type couplings may in some instances be permitted instead of flanges.

Pipe sections through walls below ground or water level shall be provided with a puddle flange the same diameter as a standard flange. The encased area shall in such cases be uncoated up to 30 mm inside the wall surface and coated to Specification from there on.

D11.2.8. Isolation

The layout design shall make provision for isolation and easy removal of mechanical equipment.

D11.2.9. Nozzles for Fittings, Gauges, etc.

Nozzles on pipework (for installation of gauges, transmitters, drain pipes, cooling water take-offs, air release valves, etc.) shall be designed so that the pipework corrosion prevention system is not affected.

Nozzles shall consist of a flanged, welded tee-off of at least 100 mm diameter, painted or cement-lined internally and provided with a non-corrosive blank flange, e.g. grade 316 stainless steel. The blank flange shall be provided with tapped holes suitable for the equipment installation.

Internally painted, small diameter carbon steel nozzles and screwed carbon steel tee-offs are not acceptable. Carbon steel pipework may be provided with small diameter, grade 316 stainless steel nozzles which are welded into the pipework if the Engineer considers this acceptable in the application.

D11.2.10. Flow Straighteners

If a flow straightener is specified in the Detailed Mechanical Specification, this shall be provided in accordance with: Pump Suction Flow Straightener – Plain Ended Pipe.

This design is for plain ended pipes on the suction side of pumps but the blade configuration shall apply where applicable to other applications.

D11.2.11. Pump Suction

Pump suction pipework shall be designed in accordance with good engineering practice. The following, in particular, shall be complied with:

(a) Suction pipework shall be sized, where practical, to ensure that the flow speed is no higher than 1,5 m/s.

(b) High points shall be avoided and it is preferred that the pipework slopes up toward the



pump.

(c) Air leaks shall be avoided / prevented.

(d) Reducers shall be of the unequal type.

(e) Reducers shall have a diametral reduction of no more than 50 mm per 300 mm length and shall have a parallel-sided length between the tapered portion and each flange.

(f) "Lobster-back bends" shall have a minimum of five segments. The segments welded to the pipe flanges shall be perpendicular those flanges.

(g) Flow straighteners shall be provided where specified in the Detailed Mechanical Specification.

(h) Strainers shall be provided where specified in the Detailed Mechanical Specification.

All pump suction piping which draws the pumped liquid from open sumps shall be provided with bell-mouth inlets. The bell-mouth shall have an integral flange and shall be bolted to a flange on the suction pipework.

The bell-mouth design shall be in accordance with drawing EAM-ME-SS-007.

The preferred material for the bell-mouth is glass-fibre or stainless steel 316 however cast iron suitably coated, may be acceptable.

D11.3. Pipework Installation

Pipes and fittings shall be conservatively selected to suit the application, neatly installed, straight to line and level, adequately supported and shall operate without vibration.

Installation of flange bolt hole orientation shall be "Two-on-Top".

D11.4. Valve Orientation

On sludge or raw sewage pipelines, check valves shall, wherever possible, be mounted horizontally and isolating valves with spindles vertical.

Valve handwheels shall be arranged so that they are accessible to the operators.

D11.5. Pipe Supports

Proposed designs of pipe supports shall be submitted to the Engineer for acceptance prior to manufacture. Specific requirements are:

(a) Steel supports shall be fabricated from heavy duty hot-rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed.

(b) Welds shall be "all-round".

(c) Each foot shall feature at least four anchor fasteners.

(d) For cantilevered pipe supports, the spacing between anchor fasteners shall be not less than one third of the cantilevered length

The spacing between pipe supports shall be as follows:

APPROXIMATE DISTANCE BETWEEN SUPPORTS FOR STEEL PIPE	
Pipe Diameter (DN)	Distance Between Supports (mm)
0 – 15	800
20 – 50	1 500
65 – 100	2 500
125 – 200	3 500
250 – 500	5 000
> 500	6 000

[redacted]

Distance between supports must be halved for pipe materials other than carbon steels and stainless steels.

Pipe supports shall be so located that when an item of mechanical equipment is removed, the associated valves and pipework are still adequately supported. Supports shall be provided close to heavy items such as valves. No external loads shall be placed on items of mechanical equipment such as pumps, compressors, etc. Adequate provision shall be made for expansion and contraction due to variations in temperature or pressure.

3 mm thick neoprene strips shall be placed between pipes and supports or clamps to protect the paintwork and limit corrosion. Where roller or sliding supports are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage.

Floor pipe supports shall be aligned using a nut above and below the foot. A space of at least 20 mm shall be left between the foot and the floor and this space shall be filled using non-shrink grout in accordance with the manufacturer's recommendations once alignment has been completed. Alternative designs and installations may be submitted by the Contractor.

Wall pipe supports shall be similar.

If the pipework configuration does not provide axial restraint, harnesses against separating forces shall be provided. Systems incorporating additional flanges or lugs and connected by tie bars or positively fixed to anchors will be acceptable. Systems relying purely on friction will not be acceptable. Tie bar harnesses shall incorporate three tie bars or more.

Where the Engineer approves the use of concrete pipe supports to be built by a civil contractor under a separate contract, these will be constructed after installation of the pipework and temporary supports shall be provided by the Contractor in positions which will not interfere with the construction of the concrete supports.

D11.6. Pressure Testing

All pipelines shall be pressure tested to 1,5 times maximum working pressure. Pressure testing shall be done before covering the pipeline and shall be witnessed by the Engineer.

D11.7. Flanges

D11.7.1. Flange Standards

All standard flanges shall comply with SANS 1123. For flange sizes not included in the SANS, BS 4504 shall be used. Cast iron flanges and their mating flanges shall have flat faces. The flange table shall be as specified or, if not specified, selected to suit the maximum possible operating pressure but not less than Table 1000.

D11.7.2. Flange Fixing

Flanges DN 50 and smaller may be of the screwed on type.

Metal flanges above DN 50 shall be welded on in accordance with BS 806 Type 6 unless otherwise agreed or specified.

D11.7.3. Machining of Flanges

All flanges shall be machined on the sealing face. Flanges cut from plate shall also be machined on the bore and outside diameter. Cast iron flanges shall also be machined or spot faced on the back of the flange to ensure a flat bearing surface for the fastener's head or nut and washer. All edges, including bolt-holes, shall be chamfered or rounded to a 2 mm radius.

D11.8. Gaskets

The jointing material used on flange joints shall be of rubber or compressed asbestos fibre at least 3 mm thick complying respectively with BS 2494 or BS 1832, as applicable. Full face gaskets shall be used for full face flanges. Inner bolt circle gaskets shall be used on raised face flanges and when clamping items such as wafer type valves between flanges inside the bolt circle. Properly designed O-ring seals are also acceptable.

D11.9. Flexible Pipe Couplings

D11.9.1. General

[redacted]

Where pipework movement, misalignment or dismantling must be allowed for, or if necessary for any other reason, pipe couplings may be used if approved by the Engineer. Pipe couplings shall be of the mechanical type, stainless steel bellows type or rubber bellows type.

D11.9.2. Supports and Anchors

Pipework using couplings shall be supported and anchored strictly in accordance with the coupling manufacturer's recommendations.

If the pipework configuration does not provide axial restraint, harnesses against separating forces shall be provided. Systems incorporating additional flanges or lugs and connected by tie bars or positively fixed to anchors will be acceptable. Systems relying purely on friction will not be acceptable. Tie bar harnesses shall incorporate three tie bars or more.

D11.9.3. Mechanical Pipe Couplings

Mechanical pipe couplings shall:

(a) be of rolled steel, forgings or of high grade castings;

(b) be coated;

(c) have rubber seals of a suitable grade;

(d) be supplied without centre register unless otherwise specified.

Pipe ends shall be in accordance with the coupling manufacturer's recommendations. Where machining is required, as in the case of cast iron pipes, the length of machining on each pipe shall be approximately equal to the total length of the coupling to ensure that the coupling can be separated for pipe removal.

Couplings for air applications below 60 °C shall be hot-dip galvanized for air applications above 60 °C shall be of stainless steel. Couplings for liquid applications shall be coated in accordance with System – "Hot-Applied Thermoplastic" or System – "Fusion Bonded Epoxy". Couplings for stainless steel pipework shall be stainless steel.

When couplings are part of a buried pipeline, the metallic surfaces shall be coated as specified above and then covered and wrapped. Couplings shall be covered with mastic to a smooth finish, wrapped with tape and then wrapped with a polythene sheet which is strapped in place. "Denso mastic" and "Denso tape", or equivalent products, are suitable. If the operating temperature is likely to exceed 70 °C, the mastic and tape shall be replaced with suitable grease or a suitable sealer.

D11.9.4. Stainless Steel Bellows Pipe Couplings

Stainless steel bellows shall incorporate stainless steel flanges.

D11.9.5. Rubber Bellows Pipe Couplings

Rubber bellows couplings are acceptable for machinery which is flexibly mounted and also in applications which require isolation of driven machinery from the surrounding pipework and/or structures.

The flexible material used for rubber expansion joints shall be chosen specifically for maximum resistance to bursting.

Metal backing flanges for rubber expansion joints shall be of stainless steel or hot-dip galvanized steel.

D11.10. Strainers

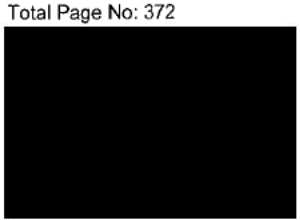
D11.10.1. General

Fluid strainers shall be selected to be suitable for the application.

A strainer is required on the suction side of all centrifugal and positive displacement pumps which draw from fluid bodies such as tanks, channels, sumps, reservoirs, etc., which have open surfaces. The Detailed Mechanical Specification gives specific requirements for strainers.

D11.10.2. Type, Design and Arrangement

Strainers shall preferably be of a proprietary type, A.R.I Semi Globe Filter, Krombach y-type, Bermad 70 F or equivalent. They shall be of the double-flanged configuration. Circular strainer



elements are preferred.

The strainer element's hole diameter shall be decided in conjunction with the Engineer.

Differential pressure reading across the strainer shall be provided. Gauges shall be provided with isolation valves as well as protection from solids contamination.

Strainers whose baskets exceed 20 litres in volume shall incorporate:

(a) top pull-out configuration;

(b) a lifting device, such as a crawl beam with hoist or a davit arrangement; and the strainer basket shall be provided with a suitable lifting eye.

(c) a hot-dip galvanized steel support or a concrete support plinth.

The ratio of open area in the strainer element to inlet pipe area for non-proprietary units shall exceed 7 and shall be designed to suit the application. Strainer elements shall be made of stainless steel perforated plate with an opening size to be decided in conjunction with the Engineer. If the Engineer approves the use of wire grid for strainer elements, the wire shall be of at least 2 mm diameter and shall be of stainless steel. Strainer elements shall be robustly constructed, shall be provided with adequate flow passages between the strainer element and body and shall withstand the differential pressure developed when a strainer element is partially blocked. Flat surfaces shall be adequately braced to prevent buckling collapse. Lids shall incorporate an O-ring type seal and shall be secured with grade 316 SS, or better. Handles shall be provided on baskets of 20 litres or smaller.

All sharp edges on the strainer's internal surfaces and on the basket shall be removed.

D12. CONDENSATE TRAPS FOR SEWAGE GAS

Condensate traps shall be of the automatic float operated type which shall not permit the escape of gas. For pipeline condensate removal a valve with I" BSP pipe connections shall be used.

Sewage gas is generally at a very low pressure and often contains sticky solids. The valve of the condensate trap shall therefore be provided with an orifice and a seat of large area using a soft sealing element. The valve shall not be subject to sticking and shall preferably be of a ball type.

The body shall be of either cast iron suitably coated internally and externally or of aluminium. All other parts shall be of 316 stainless steel.

Condensate traps shall be provided with an isolating valve and valved bypass.

D13. FLAME ARRESTERS

Flame arresters shall have 316 stainless steel or aluminium bodies and 316 stainless steel elements. For all normal duties flame arresters shall be of a type which incorporates a fusible plug controlling an automatic shut off valve. Alternatively a separate thermally operated valve may be incorporated. Flame arresters used to protect relief valves shall however not incorporate a shut off valve.

Provision shall be made in the arrangement for access to the flame barrier element for maintenance. Valves shall be incorporated to isolate the flame arrester.

The gas has a very high moisture content and the flame trap design shall minimise the entrapment of water and suitable drainage petcocks shall be provided.

Suitably valved pressure tappings shall be provided upstream and downstream of the flame arresters.

D14. PRESSURE RELIEF AND VACUUM BREAKER VALVE WITH FLAME ARRESTER UNIT

The valve is generally used to protect anaerobic digesters and shall suit this duty.

The valve shall be of a type using removable lead weights on the pressure pallet. Each lead weight shall represent a pressure of 25 mm W.G. and the valve shall be supplied with sufficient weights for the pressure given in the Detailed Mechanical Specification. Below this pressure setting the valve shall not leak. The vacuum pallet shall be set to 50 mm W.G.

The valve shall be of aluminium construction with 316 stainless steel wire mesh screens over the intake and exhaust ports. Pallets shall be centre and side guided and provided with seat inserts of a suitable material which is not subject to distortion. Seat rings and pallets shall be removable.

[redacted]

A flame arrester (of a type not incorporating a shut off valve) shall be installed between the digester and the relief valve.

The complete relief valve/flame arrester unit shall be sized to permit a pressure relief gas capacity of 5 m^3/min with a pressure increase not exceeding 25 mm W.G. and a vacuum relief air flow of 10 m^3/min at a vacuum of approximately 150 mm W.G.

D15. VALVES

D15.1. General

The valves to be used on the more common applications are specified below.

Where special valves are necessary for special applications, these will be specified in the Detailed Mechanical Specification but, if not, tenderers must select suitable valves and provide details in the tender.

The valve-hand-wheel, valve-lever, valve-actuators and valve-gearboxes to be supplied and installed for the Bulk Water Department of the City of Cape Town shall be configured to be anti-clockwise closing unless unobtainable. All valves supplied and installed for other Departments in the City of Cape Town shall be clockwise closing.

Department	Valve Closing Direction
Bulk Water	Anti-Clockwise closing
Waste Water and all other	Clockwise closing

D15.2. Requirements for All Valves

All valves shall comply with the following (unless inapplicable):

(a) Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

(b) Valves shall be double-flanged unless unavailable or otherwise specified.

(c) Valves and their method of actuation shall be designed to operate under the full pressure rating of the valve.

(d) If not obvious from the configuration, all valves, including valves with gearboxes and valves with actuators, shall be provided with an indication of the current position as well as an indication of the closing and/or the opening direction.

(e) Spindle covers shall be provided for valves with rising spindles.

(f) The specific application shall be taken into account in the corrosion protection of valves.

(g) Cast iron valve components, including valve bodies, shall be protected with System – "Fusion Bonded Epoxy" or System – "Hot-Applied Thermoplastic".

(h) Metal plating of ferrous materials is not an adequate corrosion protection system.

(i) Lever handles on small bore valves and position indicator plates shall be of stainless steel.

(j) Fasteners shall be of grade 316 SS, or better. This applies to all fasteners on the body of the valve and its gearbox. Pipework flange bolts are specified elsewhere.

D15.3. Cast Iron Gate Valves with Resilient Seals

Resilient seal gate valves may be used on raw sewage, raw water, effluent and general duties where some solids may be present but must not be used on high solid applications such as sludge and grit duties. The valves shall comply with the following:

(a) The valves shall comply with SANS 664 or SANS 665, Class 10 or higher as required.

(b) The valves shall be double flanged.

(c) Valves shall have rising spindles unless otherwise specified or necessary because of space restrictions. Non-rising spindle valves shall be fitted with indicators showing the valve opening position.

(d) Handwheels shall be of cast-iron.

[redacted]

(e) The spindle shall be of grade 316 SS, or better.

(f) Fixing lugs for end of travel limit switches shall be provided

(g) Handwheel size and construction shall permit easy opening of the gate when subjected to a differential pressure equal to the maximum operating pressure anticipated. Suitable gearboxes shall be fitted to provide easy opening when necessary. These gearboxes shall be grease filled.

(h) Valves larger than DN 150 shall be provided with bypass arrangements.

D15.4. Cast Iron Gate Valves (Wedge Gate)

Wedge gate valves shall be used on raw water and treated water duties but shall not be used on raw sewage, raw water, effluent, sludge and general duties where some solids may be present. The valves shall comply with the following:

(a) The valves shall comply with SANS 664 or SANS 665, Class 10 or higher as required.

(b) The valves shall be double flanged.

(c) The material of the body seat and the material of the gate trim shall be of copper alloy or stainless steel.

(d) The body shall be provided with channel guides for gate travel. The gate shall be provided with shoes which slide within the channel guides. Guides and shoes shall be of a copper based alloy or of stainless steel and shall guide the gate along the complete travel distance.

(e) Fixing lugs for end of travel limit switches shall be provided.

(f) Valves shall have rising spindles unless otherwise specified or necessary because of space restrictions. Non-rising spindle valves shall be fitted with indicators showing the gate position.

(g) The spindle shall be of grade 316 SS, or better.

(h) Handwheels shall be of cast-iron. Handwheel size and construction shall permit easy opening of the gate when subjected to a differential pressure equal to the maximum operating pressure anticipated. Suitable gearboxes shall be fitted to provide easy opening when necessary. These gearboxes shall be grease filled.

(i) Valves larger than DN 150 shall be provided with bypass arrangements, normally isolated by brass ball valves.

(j) Valves larger than DN 250 shall be provided with doors for inspection and cleaning.

(k) The valves shall comply with the additional requirements of W&S-BW015:1993 where applicable.

D15.5. Knife-Gate Valves

Knife-gate valves shall be used on water sludges as well as on primary, waste activated and digested sludge duties. They shall also be used on raw sewage and other liquid/solids application and may be used for duties specified under Clause "Cast Iron Gate Valves with Resilient Seals".

The valves shall comply with the following:

(a) Valves shall have cast iron bodies, stainless steel blades, cast handwheels, and shall have no carbon steel parts.

(b) Valves shall be clockwise closing (with the exception of valves for the Bulk Water Branch which shall be anti-clockwise closing).

(c) Valves shall have chamfered blade edges and resilient body seals.

(d) Blade faces shall be surface ground or otherwise provided with two flat, parallel surfaces.

(e) The blade seal shall be protected by a non-metallic scraper or similar device.

(f) Suitable sealing shall be provided to prevent leakage from the valve and it shall be possible to adjust these seals while the valve is in line under pressure.

(g) Valves shall be droptight but need not be designed for bi-directional flow unless called for in the Detailed Mechanical Specification.



(h) Internal and external surfaces of the valve body shall be protected with a water resistant, non-toxic and non-tainting, FBE pipe coating in accordance with System – "Fusion Bonded Epoxy".

(i) Valves shall be double-flanged and shall suit the standard flange rating but may incorporate drilled and tapped fastener holes (wafer type valves will be considered for acceptance only where it is unlikely that the pipe or flanged item on either side will have to be removed or if isolation will not be necessary if it is removed). Fasteners may be studs or setscrews manufactured to suit the tapping depth.

D15.6. Waterworks Type Butterfly Valve

These are the type which utilise a replaceable rubber seal with retaining ring and shall be used on raw and potable water duties. Valves shall comply with W&S-BW001:1995.

D15.7. Resilient Seal Butterfly Valves

These are the type which either utilise a resilient body liner with a stainless steel disc or utilise a resilient-lined disc for sealing. They may be used on air, gas and clean liquid duties where approved by the Engineer and shall comply with the following:

(a) Shafts and fittings shall be of stainless steel and bearing bushes shall be of Teflon or similar. Seals shall be selected to suit the application. No carbon steel components shall be permitted internally and externally such components shall be properly protected.

(b) Valves shall be air, gas and water tight when closed, as applicable.

(c) Hand lever valve actuation with a locking system for incremental valve setting from fully shut to fully open shall be provided for valves up to and including DN 200. Valves larger than DN 200 shall be equipped with robust, weatherproof grease-filled gearboxes with an indicator to show the degree of valve opening.

(d) For normal usage, the valves may be of the type which is clamped between two flanges. Where it is necessary to remove equipment on either side for maintenance purposes, suitable spacer pipes must be provided or the valves shall be flanged and provided with drilled and tapped holes.

(e) The valves shall be installed with their disc shafts in horizontal orientation.

D15.8. Bronze Isolating Valves

These may be used for isolating duties on clean air and liquid duties up to DN 50.

Bronze gate valves shall be to SANS 776.

Ball or plug valves of appropriate construction may also be used where preferred.

D15.9. Diaphragm Valves

Diaphragm valves may be used on air, sewage, sludge and other dirty or corrosive liquid duties as well as clean liquid duties. The diaphragm material shall be suitable for the fluid to be carried.

Valves shall be double-flanged and shall preferably be of the straight-through type. The weir type may be used for control valve duties. The design shall allow for replacement of the diaphragm without removal of the flanges from the line.

This type of valve shall not be used on the suction side of pumps or on any line subject to vacuum unless designed specifically to cope with design conditions.

D15.10. Needle Valves (above DN 150)

Needle valves, VAG Plunger Valve or equivalent, shall be used for the regulation of flow and/or pressure in pipelines containing water where the size is DN 150 or greater unless this is overridden by the requirements of the Detailed Mechanical Specification. The configuration shall be double-flanged with co-axial flanges unless otherwise specified.

The seal seat and associated downstream parts shall be selected to prevent any cavitation for the application. Such parts shall be of stainless steel or copper based alloy.

D15.11. Telescopic Overflow Valves

Telescopic overflow valves, (Fulton, or equivalent), shall be vertically mounted and shall be specifically designed for the purpose intended.

[redacted]

Operation shall be by hand-wheel mounted on an independently mounted headstock. Rising spindles are preferred. The outer tube shall be flanged and bolted to a similarly flanged vertical pipe. The inner tube shall incorporate a conical bell-mouth. The bridge connecting the inner tube to the valve's spindle shall be attached to the outside of the bell-mouth in order to limit the effect of fouling rags, etc.

The spindle shall be of grade 316 SS, or better. The outer tube and inner tube shall be of 3CR12. The headstock and hand-wheel shall be of painted cast iron or painted 3CR12.

D15.12. Level Control Valves

Level control valves which do not incorporate pilot control are preferred, VOSA Series 7354 or equivalent.

Level control valves which incorporate pilot control shall be simple to check and to maintain. A suitably sized strainer shall be provided to prevent blockage of the pilot. The strainer shall be self-cleaning or shall be easily cleaned.

Level control valves which are not proprietary items and which incorporate linkages shall be designed with overall strength and rigidity in mind. The design shall incorporate an allowance for fatigue effects.

D15.13. Check Valves (Non-return Valves)

D15.13.1. General

Where special valves are necessary for special applications, these will be specified in the Detailed Mechanical Specification but, if not, tenderers must select suitable valves and provide details in the tender. Check valves to be used on the more common applications are specified below.

Single-door and double-door check valves shall comply with SANS 1551-1.

Bronze swing type check valves may be used for pipework up to DN 50.

D15.13.2. Requirements for All Check Valves

Check valve installations shall comply with the following:
Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

(a) Valves shall be double-flanged unless unavailable or otherwise specified.

(b) Valves shall be designed to function correctly under the full pressure rating of the valve.

(c) The specific application shall be taken into account in the corrosion protection of valves. Steel and cast iron valve components, including valve bodies, shall be protected with System – "Fusion Bonded Epoxy" or System – "Hot-Applied Thermoplastic".

(d) Check valves shall be sized to open fully at the system's design flow rate.

(e) The check valve installation shall ensure that the valve is able to operate without interference from a physical obstruction such as a shut-off valve, bend, mortar lining, etc. Where a check valve is located close to another valve, a straight pipe shall be provided and this shall have a flange-to-flange length of not less than 1,5 times the valve diameter.

(f) Indelible body markings, as per SANS 1551-1, shall include the manufacturer's name, pressure rating (PN), nominal size (DN) and the direction of flow.

(g) A shut-off valve shall be installed downstream of each check valve.

D15.13.3. Axially-Sprung Check Valves for Water

Axially-sprung check valves (nozzle check valves) for treated water and raw water duty shall be double-flanged; RGR Concentric, Vent-O-Mat Maxiflo or equivalent.

The valve design shall prevent shock closing and shall incorporate a hydrodynamic efficient flow path to minimise head loss.

The spring shall be of stainless steel and the guide rod shall be supported within a non-corroding, non-galling bearing material.

Double-Flap Check Valves for Water

[redacted]

Double-flap check valves for treated water and raw water duty shall be of the positive-closing type; Crane Duo-Check II or equivalent.

Bodies shall be of cast-iron or cast-steel. Flaps shall be of the light, leaf type, shall be of bronze or stainless steel with machined sealing faces, shall be specifically designed to be non-sticking, and shall have Teflon bearing washers. Seals shall be of resilient material. The axis of rotation of the flaps shall be vertical, pins shall be of 316 SS, or better, and closure shall be initiated by stainless steel springs, suitably rated for the duty so that closing is initiated prior to the onset of reverse flow.

Positive, external indication of the position of both plates shall be provided.

D15.13.4. Rubber Diaphragm Check Valves

Rubber diaphragm check valves shall be of the double-flanged configuration and shall incorporate a hydrodynamically efficient flow path to minimise head loss; VAG Top-Stop or equivalent. Valves featuring multiple small orifices will only be acceptable for nominal flow speeds below 0,5 metres/second.

The flexible rubber diaphragm shall be replaceable.

D15.13.5. Ball Check Valves

Ball check valves, AVK Series 53 or equivalent, may be used on sewage, sludge or similar applications.

The ball shall be rubber coated and it shall be possible to inspect and/or replace it without removing the valve from the pipework.

D15.13.6. Swing Check Valves

Suitably designed swing check valves may be used on sewage, sludge or similar applications. Orientation of the valve shall comply with the manufacturer's recommendation.
Swing check valves shall:

(h) be of double-flanged configuration.

(i) have ductile iron bodies.

(j) be suitable for a working pressure of at least 1 000 KPa.

(k) be fitted with a side lever and adjustable weight.

(l) be provided with a bolted cover which provides access, without dismantling or removing the valve, to the swing flap.

(m) have stainless steel hinge pins.

(n) have engineered plastic or non-ferrous bearings.

D15.14. AIR RELEASE VALVES

Air release valves for water pipework shall be of the non-slamming type, A.R.I. or Vent-O-Mat or equivalent.

Valves for sewage and similar duties shall be specifically designed for the application.

Air valves shall be installed above pockets designed to collect the air entrained with the water flow. The diameter of the nozzle shall be at least half the diameter of the parent pipework.

Valves shall have flanged connections and shall be provided with upstream isolating cocks.

D16. VALVE ACTUATORS

D16.1. General

Manual operation, by lever, hand wheel, shall be provided on all actuators unless otherwise specified.

Metal plating of ferrous materials, (e.g. zinc or cadmium plating) is not an adequate corrosion protection system for items such as actuator shafts and such items shall be provided with an additional coating of a semi-setting, thick protective layer, such as a suitable Tectyl product, or equivalent.

D16.2. Electric Actuators

[redacted]

Electric actuators shall be specifically matched to the design duty. Actuators providing modulating duties shall be specifically designed for continuous modulation.

The actuator motor and gearbox shall form one integrated unit. Motors shall be for three phase, 400 Volt, 50 Hz supply, shall be Class F insulated (or better) and shall have an embedded thermostat for overload protection. The complete unit, including installation work, glands and controls shall be ingress protected to IP 68 unless otherwise specified.

If the opening or closing period is specified in the Detailed Mechanical Specification (e.g. to avoid water hammer) this period shall be achieved, without pulsing, by incorporating a suitable gear ratio to allow the motor to operate from fully open to fully closed without stop/starts.

For open/shut duties, the continuous actuator torque rating shall be at least 200 % of the start-opening or shut-off torque, whichever is higher, specified by the valve manufacturer for this application (after the gearbox mechanical advantage has been taken into account). For modulation duties, the continuous actuator torque rating shall be at least 400 %.

All components of the drive shall be designed to prevent backlash.

Electric actuators shall incorporate the following features:

hand operated gearwheel override operation incorporating open/close direction indication.

visual valve position indication at the unit.

the terminal compartment shall be separately sealed from the internal electronics and mechanisms.

the actuator shall initiate a trip if:

- it does not succeed in moving the valve within a suitable period.
- the motor windings overheat.

Where specified in the Detailed Mechanical Specification, the following shall be provided:

(a) the actuator shall provide an impact effect to overcome:

⊕ tightly seated valves.

⊕ an unintended loss of movement.

(b) the following information shall be fed back to the control panel or, if applicable, the SCADA system:

⊕ valve position.

⊕ torque on output shaft.

(c) it shall be possible to configure the control instructions and interrogate the actuator status without removing covers.

D16.3. Pneumatic Actuators

Pneumatic actuators shall be selected to match their valves' operating requirements.

Actuators shall be fabricated of non-corrosive materials and shall be mounted using stainless steel mounts and couplings. Fasteners shall be of stainless steel.

Unless the system configuration clearly does not require it, automatic spring-closing shall be provided to ensure that the valve closes (if open) or remains closed (if closed) upon power failure or failure of the air supply. The spring shall be of stainless steel.

Linear actuators shall be provided with stainless steel cylinder piston, cylinder rod and attachments. For open/shut duties, continuous actuator force rating shall be at least 200 % of the start-opening or shut-off force, whichever is higher, specified by the valve manufacturer for this application (after any mechanical advantage has been taken into account). For modulation duties, continuous actuator force rating shall be at least 400 %.

For open/shut duties of rotational actuators, continuous torque rating shall be at least 200 % of the start-opening or shut-off torque, whichever is higher, specified by the valve manufacturer for this application (after any mechanical advantage has been taken into account). For modulation duties, continuous actuator torque rating shall be at least 400 %.

The air supply upstream of each actuator shall be fitted with a filter-regulator unit with an

[redacted]

automatically operating water drain trap.

D17. BASEPLATES

D17.1. Baseplate Configuration

Both direct-coupled and belt-driven machines shall be mounted with their drivers on common cast iron or fabricated steel baseplates of rigid construction.

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted to the concrete plinths, shall be provided. No machine may be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

D17.2. Corrosion Protection

Steel baseplates shall be hot-dip galvanized unless specified otherwise in the Detailed Mechanical Specification.

D17.3. Drainage

Baseplates shall be configured to prevent pooling of water. Baseplates shall be either fully grout filled or provided with drain holes in all side members.

D17.4. Machined Mounting Pads

The baseplate shall incorporate machined mounting pads at the support and fixing positions of each item of plant and equipment to be mounted on the baseplate. On fabricated baseplates this machining shall be done after fabrication, stress relieving (if applicable) and hot-dip galvanizing are complete. The thickness of the mounting pads shall be not less than 1,25 times the diameter of the holding down bolts. The pads shall not be provided with threaded holes for machine screws but shall be drilled for inserting through-bolts and adequate provision shall made for reaching the nut with a suitable spanner. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevice formed at the foot of the equipment.

The above design may be suitably modified if the Contractor uses a pourable resin based chocking system. Such chocks shall be at least 15 mm thick.

D17.5. Shimming

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.

D17.6. Jacking Arrangement

At least two diagonally opposed jacking screws shall be provided for belt tensioning in the case of belt-driven units. Direct-coupled motors above 10 kW shall be provided with jacking screws for horizontal alignment and direct-coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be of grade 316 SS, or better.

Drilled and tapped flat plate is not acceptable for jacking points. A jacking point shall consist of a suitable hot-rolled steel section welded to the baseplate and with a captured machine nut to accept the jacking screw.

D17.7. Grouting

Baseplates shall be designed and grouted to eliminate collection points for water or dirt. Except where otherwise approved in writing by the Engineer, all baseplates on concrete plinths shall be fully grouted in. Grouting holes must be provided on baseplates having a continuous top plate. Tapped holes and fixing setscrew protrusions shall be suitably protected.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if the Contractor's design requires an epoxy grout to be used.

The initial grouting shall be overseen by the grout supplier's technical representative.

D17.8. Alignment

Preliminary alignment of equipment mounted on baseplates shall be done at the factory to ensure that the baseplate has been correctly manufactured, but final alignment shall always be done on Site after installation and grouting has been completed. Alignment shall be accurate and to the

[redacted]

approval of the Engineer and a final alignment check witnessed by the Engineer must be carried out by the Contractor prior to start up.

D18. PENSTOCKS

D18.1. General

Penstocks shall be of the rising spindle stem configuration. Where impractical preference shall only be given to non-rising spindles in instances where limited head room is available

D18.2. Reference Documents

The following documents are to be used in conjunction with the standard specifications and are available upon request

Standard Penstock example drawing: EAM-ME-SS-008

Quality Control Procedure: Penstocks: EAM/D&C/QCP/013

D18.3. Design

Penstocks shall be designed to be operated under full design pressure for both manual and power actuated operation. The headstock beam shall be designed to accommodate the door opening and closing forces with no visible deflection while under maximum on/off-seating head pressure.

Preference for a P-Type seal arrangement or equivalent for a positive action bearing pressure on seal surface when hydraulically loaded.
A system of adjustment shall be provided for ensuring that the penstock door is held against the seal correctly. Side wedge door adjusters shall be provided. Top and bottom wedge door adjusters shall be provided where required by the installation.

The upper and lower frames shall be split and bolted for ease of installation. The frame shall have jacking bolts for perpendicular and horizontal alignment (taken in both plains).

The door shall slide between polymer, elastomer or non-ferrous alloy materials. Direct contact between the door and the frame is not acceptable. Seals shall be mounted on the face of the gate. The mounted seal shall have protrusion in the range 5-10mm.

Wedges, guides, seals, door nuts and drive sleeves shall be replaceable.

Spindle covers shall be provided for penstocks with rising spindles. Spindles shall be designed such that they are of sufficient section to prevent buckling or deformation when subjected to:

- The actuator at maximum stall torque

- 270N rim pull force applied to the hand wheel

In applications where penstocks are installed without Power Actuators the design shall be such that a minimum rim pull force of 100N / 10kg is required to open or close the valve manually.

Spindle bearings shall be spherical flange mounted thrust bearings. Brass end travel stops need to be fitted to prevent damage to the Spindle thread when over tightened.

Penstocks which are acted on by long stems shall be provided with guides along the length of the stem and the spacing between these guides shall not exceed 1 800 mm.

All power actuated penstocks shall include manual override and the power actuators shall be of fail-safe design. Lubrication of spindles shall be considered during design and specified in the operation and maintenance manuals.

D18.4. Materials

The penstock door and frame shall be of grade 316L S/S, LDX or better.

The door guides, seals, door nut and drive sleeve shall be of polymer, elastomer or non-ferrous alloy materials.

All fasteners, muff couplings and stem adaptors shall be of grade 316 S/S, or better. Universal joints shall be of stainless steel and shall be provided with rubber gaiters for protection.

Copper alloy seals shall not be used on sewage applications. All material shall be compatible with sewage water and sewage gas.

[redacted]

D18.5. Fabrication

In the instances where full continuous welding would have had a negative impact on the design of the Penstock Valves, waver for stitch welding is granted and agreed to by the Engineer, on provision that all the non-welded seams are sealed with a non-hardening Polyurethane Sealant.

Cast iron handles shall be of a minimum diameter 500mm in applications where non-Powered Actuators are fitted and shall be FBE (Fusion Bonded Epoxy) coated or normal epoxy-coated. Direction of the hand wheel shall be as per the table below. The directions shall be labelled on the handles.

D18.6. Installation

Penstocks shall be installed by the Contractor using personnel skilled in such installations.

Suitable gaps shall be left for the application of grout. Grout shall be of the non-shrink type and shall be applied strictly in accordance with the manufacturer's instructions. The first penstock to be installed shall be grouted under the supervision of the grout supplier and in the presence of the Engineer.

D18.7. Leakage Testing

Leakage testing shall be done under maximum expected pressure and after all installation work has been completed. No leakage between the penstock frame and the structure shall be acceptable.

The acceptable leakage rate shall be:

(a) 0,015 ℓ/s/m of seating perimeter/3 m pressure head (for off-seating penstocks);

(b) 0,008 ℓ/s/m of seating perimeter/3 m pressure head (for on-seating penstocks).

On head pressure up to 5m, acceptable leakage rates shall be:
Less than 0.1 litres per metre per metre of seal periphery for wedge type gates,

- Less than 0.3 litres per minute per metre of seal periphery for all other types of control gates and
- Less than 0.5 litres per minute per metre of seal periphery for stop boards or bulkheads

For head pressure 5m and above, acceptable leakage rates shall be calculated using the following formula:

$R_{lm}=0.1+0.0H_{os}$

Where:

H_{os} = on/off – seating head, in metres

R_{lm} = leakage rate in litres/minutes per metre of seal

D19. MACHINE GUARDS

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended and the following points shall also be complied with:-

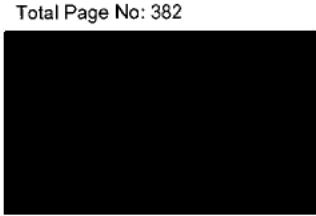
(a) Guards are required to cover all moving or revolving components of machinery. Guards which do not adequately cover moving protrusions such as keys, lock-nuts, lockwashers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.

(b) Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

(c) Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 20 mm or larger to penetrate.

(d) Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required.

(e) Guards shall completely enclose drives and shall entirely prevent a person from touching any moving protrusion.



(f) It shall be possible to remove the guard easily for equipment maintenance and adjustment purposes.

D20. INGRESS PROTECTION (IP)

The IP rating normally has two (or three) numbers:

1) Protection from solid objects or materials
2) Protection from liquids (water)
3) Protection against mechanical impacts (commonly omitted, the third number is not a part of IEC 60529)

	X Protection against solid objects	Y Protection against liquids
0	No special protection	No protection
1	Protected against solid objects over 50 mm, e.g. accidental touch by persons hands	Protection against vertically falling drops of water e.g. condensation
2	Protected against solid objects over 12 mm, e.g. persons fingers	Protection against direct sprays of water up to 15o from the vertical
3	Protected against solid objects over 2.5 mm (tools and wires)	Protected against direct sprays of water up to 60o from the vertical
4	Protected against solid objects over 1 mm (tools, wires, and small wires)	Protection against water sprayed from all directions - limited ingress permitted
5	Protected against dust limited ingress (no harmful deposit)	Protected against low pressure jets of water from all directions - limited ingress
6	Totally protected against dust	Protected against temporary flooding of water, e.g. for use on ship decks - limited ingress permitted
7		Protected against the effect of immersion between 15 cm and 1 m
8		Protects against long periods of immersion under pressure

Ingress Protection of electronic instrumentation shall be as follows:

(a) Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.

(b) Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self-draining.

(c) Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all-round the instrument.

Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.

Calibration certificates shall be included in the Manual.

Pressure Gauges shall measure gauge pressure (i.e. not absolute pressure).

D21. ELECTRIC MOTORS

D21.1. Rating

Electric motors rating shall be specified in the detail specification and can either be:

- AC, 3phase, 3300Volts, 50Hz

[redacted]

- AC, 3-phase, 4-wire, 400/230 Volt, 50 Hz.
- AC, Single phase, 220 Volt, 50 Hz
- DC, 24Volt

All motors supplied shall be IE3 Premium Efficiency type according to International Efficiency standard IEC 60034-30-1, which has defined efficiency levels for three-phase induction motors.

The rated power of the motor shall be selected to be not less than 15% in excess of the designed power requirement of the associated plant unless the motor forms part of a packaged unit and/or where the size of the motor is specified and/or as otherwise approved by the Engineer.

A motor shall be selected so that it shall reach full operating speed within 10 seconds for the method of starting and drive arrangement used.

D21.2. Specifications

Except as otherwise specified, motors shall be standard squirrel cage or slip-ring motors with SANS 1804 approved certification, with IP66 enclosure and shall be, totally enclosed fan cooled (TEFC), suitable for use outdoors, exposed to direct sunlight and heavy rainfall as well as suitable for use indoors in wet and damp environments.

Windings shall be copper conductors insulated with Class H material (180 °C highest temperature capability) with Class B temperature rise (80 °C).

Motors shall be suitable for Class S1 Duty for continuous running duty, and where applicable for Class S3 Duty for intermittent periodic duty. Motors shall be capable of operating continuously at their nominated full load ratings, notwithstanding variations of ±10% from the designed voltage, or ±2% from the designated frequency of the supply, i.e. Zone B operation in accordance with IEC 60034-1.

Due to high starting currents on electric induction motors, the time required to accelerate high inertia loads will result in a sudden motor temperature rise. If the interval between successive starts is very short, motor windings can experience some overheating that will cause some damage or reduce their lifetime. IEC 60034-1 Standard establishes a minimum number of starts (Class S1 Duty) that the motors should withstand in the following conditions:

a) Two consecutive starts: first start with the motor in cold state, i.e., with the windings at ambient temperature and the second start right after, but with de-energized motor and at rest.

b) One hot start, i.e., with the windings at running temperature.

The motor nameplate will be stainless steel and will contain information that describes the construction characteristics and the performance of the motor shall include the following information:

Name of manufacturer	Frequency
Country of manufacture.	Connection diagram
Serial number.	Ambient Temperature
Frame Size	Service Duty
Class of insulation	DE & NDE bearing details
Phase indication	Re-greasing intervals, and type of grease
Rated output in kW	Ingress Protection rating
Rated Voltage	Weight in kg
Rated Current	Efficiency rating – IE code
Rated Speed	Power factor and efficiency
Service Factor	SAN 1804 -1 & 2 and Permit number
SABS "approved" mark	

[redacted]

D21.3. Type

The type of motor (and starter if applicable) to be supplied is determined by the requirements of the application specified in the Detailed Mechanical Specification and by the starting limitations specified in the Electrical Specification. In the absence of such specifications, a standard squirrel cage motor complying with this Clause shall be offered.

D21.4. Motor Frame

Motor frames shall be of the totally enclosed fan cooled type with cast iron frames and cast iron end covers. Sheet steel is not acceptable for fan cowls and these shall be of cast iron, polymer plastic or stainless steel. The end shields and stator frame spigots shall be properly machined and each end shield shall locate on a spigot to ensure concentricity and parallelism.

Motors with a frame size of 100L or larger in accordance with IEC 60034 standards shall be equipped with adequate lifting facilities such as eye bolts. Motors frame size 225S/M and larger shall be fitted with re-greasable bearings and endshields with suitable grease relief system.

Motors frame size 315 and 355 shall have an insulated NDE end-shield or bearing and shall be fitted with a drive-end earth brush.

Motors required for external use shall be fully weatherproofed and shall have a minimum Ingress Protection rating of IP66 and with a W3 sealing system on the end shields on motors with a frame sizes of 225 to 355. This sealing system consists of a v-ring with double lips and metal cap mounted on this ring to protect the motor against accumulation of solid and liquid impurities present in environment.

All motors shall be dynamically balanced with half keys and to have an open key way. Motors frame size 280S/M and larger are to be fitted with labyrinth type seals.

All motors fitted with roller bearings shall be fitted with a suitable shaft locking device and preferred motor bearings are to be SKF, FAG or a suitable manufacturer approved brand.

Motor noise limits must comply with the latest SANS/IEC 60034-9 requirements.

D21.5. Terminal Boxes

Terminal boxes shall be top mounted wherever possible and arranged for cable entry from either side. The two ends of each stator winding shall be "brought out" to the terminal box. Squirrel cage motors shall be wired to permit both direct-on-line and star-delta starting. All motors shall be fitted with an earthing stud in the terminal box, motors frame size 160 and larger shall be fitted with an additional external earth stud. Separate terminal boxes shall be provided for ancillary connections.

Except as otherwise specified, Terminal boxes shall satisfy ingress protection rating of IP 66.

D21.6. Thermistors

Motors with a frame size 225 to 280, as well as motors used with variable speed drives, shall be fitted with a winding temperature detectors, type PTC thermistor, one per phase (1/Phase) embedded in the motor windings. The PTC thermistors shall be connected on separate terminals located in the Auxiliary terminal box mounted externally near the motor main terminal box.

D21.7. Resistance Temperature Detector (RTDs)

Motor windings RTD's

Motors frame sizes 315 and larger as well as motors used with variable speed drives, shall be provided with PT100 resistance temperature detectors (three-wire configuration type). Two RTDs shall be provided per phase winding. All six shall be incorporated into the control system; three to provide monitoring and three to provide trip functions.

These RTD's shall be connected/terminated on separate terminals located in the Auxiliary terminal box mounted externally near the motor main terminal box. All six shall be incorporated into the control system to provide monitoring and trip function.

Motor Bearings RTD's

Motors frame size 315 and larger as well as motors used with variable speed drives shall be fitted with Bearing Temperature Detectors type PT100, one per bearing (1/Bearing). These RTD's shall be incorporated into the control system to provide monitoring and high temperature trip functions.

These RTD's shall be connected on separate terminals located in the Auxiliary terminal box

[redacted]

mounted externally near the motor main terminal box. Motor Bearings RTD's shall be incorporated into the control system to provide monitoring and high temperature trip functions.

D21.8. Space Heaters

The space heaters are installed inside motors of frame size 250 and larger or when it operates in high-humidity environments, (humidity> 95%) and when it remains out of operation for periods longer than 24 hours, thus preventing water accumulation inside the motor by the condensation of humid air. These Heaters is to be switched off when the motor starts operating. The space heaters will be supplied to operate on 220 VAC supply voltage.

D21.9. Slip-Ring Motors

Slip-ring (wound rotor) motors shall be of the totally enclosed fan cooled type with stainless steel slip-rings. The slip-rings shall be mounted inboard of the non-drive end bearing and shall be fitted and keyed to the shaft as a single unit. The terminal box shall be common to both stator and rotor connections.

The brush holders shall be manufactured from fibreglass and shall be removable from the terminal box as a complete unit. Where the current density in a single brush at the full operating load approaches or is above 80 % of the capability of the brush, then an additional brush shall be provided in a separate brush box.

D21.10. Motor Speed

Motor speeds shall be selected as follows:

(a) Electric Motors with output ratings below 30 kW can have nominal speeds up to 3 000 rpm.

(b) Electric motors with output ratings between 30kW and 132kW, both inclusive, shall selected to have a nominal speeds rating of up to 1500 rpm.

(c) All electric motors with output ratings 160 kW, inclusive, shall have a nominal speeds rating up to 1500 rpm.

D21.11. Diagnostic Monitoring devices

Electric motors with an output rating of 22 kW and above shall be fitted with an add-on diagnostic or performance monitoring sensor on request by the City Engineer.

The sensor must be able to track and analyze vibration, temperature, speed and running time as a minimum requirement.

The sensor must transfer data in a wireless fashion via Bluetooth or Cloud syncing which must then be accessible via a smartphone, tablet or desktop computer application for review and monitoring. The data as viewed in the monitoring application must be converted into a human readable format with reports, diagnostics and graphs.

The monitoring device shall be supplied with full licensing with access to all aspects of the software and cloud storage for the entire life cycle of the device.

D22. POWER TRANSMISSION

D22.1. Shaft Couplings

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and driven machine. Couplings shall, wherever practical, be of the rubber-tyre or rubber compression type, keyed to the shafts.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used in all cases where this will assist maintenance.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

After installation, the alignment of all couplings shall be checked by the Contractor in the presence of the Engineer or a person delegated by him. Alignment shall be accurate and to the approval of the Engineer.

D22.2. Vee Belt Drives

[redacted]

Vee drives shall be designed to suit the power rating of the motor using service factors appropriate to the driving and driven machinery. Drives shall be designed, manufactured and installed in accordance with BS 3790 and ISO 4184, utilizing taperlock pulleys with taperlocks keyed to the shaft.

Where alternative pulley diameters can be selected, preference must be given to the larger pulley diameters to minimize the belt loading on bearings.

The bearing arrangements of driving and driven machinery shall cope with the loads imposed by vee-belt drives and shall incorporate lay shafts where necessary. Lay shafts shall be supported by bearings mounted in bearing housings which are adequately sealed and fitted with grease nipples. Bearing units incorporating open, shielded bearings are not acceptable.

Design calculations and drawings for lay shaft arrangements shall be submitted for acceptance by the Engineer.

D22.3. Motor Driven Gearboxes

Gearboxes shall, unless otherwise specified, be supplied with environmental protection to IP 55.

Gearboxes shall be selected using a service factor of 1,75 based on the drive rating and shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.

Gears shall be case hardened, profile ground and lapped, helical and spiral bevel gears.

The gearbox housing shall be of rigid cast iron construction preferably split in the horizontal plane.

A breather designed to prevent moisture from entering shall be fitted.

Oil-bath gearboxes shall have suitable oil level indicators or dipsticks. Unless otherwise decided by the Engineer, the drain from the gearbox shall be extended beyond the base so that the oil can be easily collected. The drain line shall be of grade 316 stainless steel and shall be fitted with a ball valve and square-head plug.

Each gearbox shall be mounted on machined sole plates fitted with jacking screws to assist with alignment.

D22.4. Gearbox

Gearboxes for screw pumps shall comply with the following:

(a) Gearboxes shall be selected using a service factor of 1,75 based on the motor power rating and shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.

(b) Roller bearings shall be used throughout. The gearboxes shall be constructed with a dry well for the low speed shaft bearing to avoid complete drainage of oil in the event of an oil seal failure and this bearing shall be grease lubricated. The greasing point shall be easily accessible.

(c) The gearbox housing shall be of rigid cast iron construction split in the horizontal plane. Oil drainage shall be provided from the lowest point on the inclined gearbox (syphon type drains are not acceptable). The drain shall be provided with a valve spout extending beyond the base so that the oil can be easily collected. A breather designed to prevent moisture from entering shall be fitted. Suitable oil level indicators or dipsticks shall be provided, these taking the angle of mounting into consideration.

(d) Reverse rotation shall be prevented. If the holdback is separately lubricated it shall be mounted on the upper face of the gearbox for maximum accessibility.

D23. CONDITION MONITORING

D23.1. General

Condition Monitoring comprises actions of collecting regular information about machinery condition to detect failures or deterioration of machinery. Measurements and observations shall be carried out during operation of the equipment at various sites within City of Cape Town. A full technical report with corrective measures should be issued upon completion of the work and feedback should be given to the responsible person / people involved.

[redacted]

The purpose of machine condition monitoring is to monitor the state of a machine and detect any deterioration in condition, to determine the cause of this deterioration and predict when failure can be expected. The result is to maximize the availability and utilization of equipment.

D23.2. Scope

This specification provides for the supply of computerised condition monitoring services within City of Cape Town sites. The service shall be provided by suitably qualified and experienced individuals and shall include labour, material and travel costs.

Data shall be collected by the Contractor onsite with hand held tools and equipment. The captured data shall then be downloaded into a database for trending and analysis.

It will remain the responsibility of the Contractor to co-ordinate his site visits with the relevant personnel prior to visiting the site. On arrival the Contractor must liaise with the relevant personnel and obtain the necessary approvals and permits before proceeding to monitor any equipment.

The Contractor must submit a full report on all data collected. Colour coding shall allow for easy differentiation of trends and data points outside normal accepted parameters.

D23.3. Vibration Analysis

The mechanical vibration of newly installed machines measured at strategic predetermined points shall be lower than that specified as "good" for that class of machine in ISO 10816 and ISO 2372. The table below shows the classification of vibration severity zones along with the relevant colours.

Table D22.3: Classification of vibration severity zones

VIBRATION SEVERITY (ISO 2372)					
Machine		Class I	Class II	Class III	Class IV
	mm/s	< 15 kW	15 – 75 kW	> 75 kW	> 75 kW
Vibration Velocity VRMS	0.28	A	A	A	A (Good)
	0.45				
	0.71	B			
	1.12		B		
	1.80	C		B	
	2.80		C		B (Allowable)
	4.50	D		C	
	7.10		D		C (Tolerable)
	11.2			D	
	18.0				D (Not permissible)
	28.0				
	45.0				

These evaluation zones are defined to permit a qualitative assessment of the vibration of the given machine and provide guidelines on possible actions.

Classifications:

- Class I: Small (up to 15kW) machines and subassemblies of larger machines.
- Class II: Medium size (15kW to 75kW) machines without special foundations or machines up to 300kW rigidly mounted on special foundations.
- Class III: Large rotating machines rigidly mounted on foundations which are stiff in the direction of vibration measurement.
- Class IV: Large rotating machines mounted on foundations which are flexible in the

[redacted]

direction of vibration measurement.

Plant to be monitored:

Analysis may be performed on each individual rotating machine component rated larger and equal to 15kW within an operating speed of 120 rpm and 3000 rpm. Machines to be monitored may include:

- Blowers and Fans
- Electric Motors
- Gearboxes
- Generators
- Pumps
- Turbines

For each point on the motors, gearbox and blower shaft bearings the Fast Fourier Transform (FFT) frequency range must be set correctly to monitor frequencies of interest i.e. bearings and gears. Vibration readings must be recorded on all machine-bearing points in the Radial, Vertical and Axial planes where permissible.

Experience and Qualifications:

Inspection personnel engaged in the execution of the work shall be adequately qualified and trained. Minimum training requirements for individuals shall be in accordance with ISO 18436-2:2014 Vibration and Condition Monitoring – Category 2 (or equivalent).

D23.4. Thermography

The Infra-Red camera shall be designed for Preventative Maintenance (PM) use by indicating areas with excessive heat build-up for mechanical and electrical equipment. This shall include electrical switchgear, transformers, motors, pumps. The camera shall be capable of viewing the heat dissipated by equipment in order that preventative maintenance may be undertaken prior to damage of the particular equipment.

Minimum IR Camera Requirements:

- Full analysis and reporting software
- Calibration Certificates
- Minimum IR resolution 160 x 120
- Minimum NETD thermal sensitivity 0.1℃ at 30℃
- Minimum temperature measurement range -20℃ to 150℃
- Temperature measurement accuracy ±2% at 25°C
- Visible camera resolution 2 megapixels
- File formats JPEG, BMP

D23.5. Oil Analysis

Category	Key Analysis
Machine Wear	Fine wear metal Large wear metal elements
Contamination	• Sand and grit • Dilution • Water/Moisture • Alien fluid • Carbon
Degradation	• Oxidation, Nitration, Sulfation • Viscosity

[redacted]

	• Acid number (AN), • Base Number (BN) • Additive package

Oil Sampling Best Practices:

Referring to Original Equipment Manufacturer (OEM), workload of machinery as well as Project Plan where applicable, both vibration testing and oil sampling should be conducted on the same day to minimise site visits and machine lockout.

Pertinent questions to consider when arriving at a sampling interval include:

- Hazard Identification and Risk Assessment
- Criticality of equipment (or lack of redundancy)
- Environment (is it wet, dry?)
- Operating conditions (load, speed)
- What is the failure history?
- How costly is a failure? In repair cost?
- Have operating conditions changed to put more stress on the machine?

A representative oil sample should be taken at the same location using the same method each time, as the following table indicates:

Equipment	Sampling Point
Engine Crankcases	-Through dipstick holder -Sample valve on crankcase sump wall -Return line before filter
Hydraulic Systems	-Sampling Valve on return line before filter -Reservoir - mid-point, away from reservoir walls
Compressors	-Crankcase: about midpoint away from crankcase walls -Return line after oil separator
Gearboxes	-Sump: mid-point. Avoid sump floor sludge and side wall deposits
Turbine Systems	-Reservoir – mid-point, keep away from sidewalls and baffle plates -Main bearing return line -Secondary points-after bypass filtration system

Sampling shall take place under the following conditions:

- While the machine is operating, provided no spilling can occur.
- Samples shall always be taken from the same point
- Individual clean specimen bottles to be supplied for each sample
- Samples taken shall be immediately labelled in detail to prevent mix up
- Sample accessories (tubes, pipes etc) to be clean & free from contamination
- Drain off dead leg oil/water/debris before sampling
- Vacuum extraction of oil samples to used where permissible
- Samples to be taken from "free flow oil" when permissible to avoid latent contamination

Oil sampling shall not be done immediately after an oil change or makeup.

[redacted]

Facility Accreditation:

Equipment for oil sampling and facilities for testing must be accredited by SANAS according to ISO 17025.

Appropriate Standards:

The Service Provider shall provide a health and safety plan which could include written safe work procedure. Material safety data sheets (MSDS) to be provided for all chemicals, oils detergents, solvents and cleaning agents.

ISO 4406:1999 Fluid Cleanliness Standard

Contamination classes guideline as per ISO Classification Table:

Turbines ISO Class 14/11, Compressors ISO Class 14/11, Hydraulic Systems ISO Class 15/12, Gearboxes ISO Class 16/13, Engines/Pumps ISO Class 15/12.

D23.6. Detailed Reports

All detailed reports shall include:

- Photograph of the monitored equipment nametag
- Existing fault levels
- Existing alarm levels
- Findings and recommendations
- Data capturing and analyses equipment calibration certificates

Vibration Analysis Reports

- Photographs of the monitored equipment depicting Drive-End (DE) and Non-Drive-End (NDE)
- Vibration amplitude (mm/sec) – assessed against zones
- Frequency (Hz) – refer to ISO 2954
- Plot trends and dynamic data points – Trend, spectrum and wave form
- Trend display and overall vibration levels

Thermography Reports

- IR versus visible image side by side reporting

Oil Analysis Reports

- A detailed analysis report is required with every sample taken

It will remain the responsibility of the Contractor to ensure that all data is backed up onto a reliable storage medium.

D23.7. Condition of Measurement Roots and Points

Before any data may be collected or processed the plant to be monitored must be configured in software to define the points to be monitored. All available machine data, parameters, alarm levels, and known fault frequencies must be noted.

The Contractor shall at all times utilize the most cost efficient and technically reliable technology to accurately diagnose and report on the machine health, identifying any possible defects.

The Contractor shall comment on visual inspections (oil leaks, cleanliness, loose items, blocked vent, open wires, safety issues) and general machine as well as factory condition.

D24. BEARINGS

D24.1. General

Bearing systems shall be designed to provide safe start-up and shut-down, under normal stoppages as well as electrical supply failure, without damage.

Unless prevented from running in a particular direction, rotational bearings shall be designed to support shaft rotation in both directions.

[redacted]

D24.2. Bearing Type

Bearings shall be chosen primarily to suit the equipment manufacturer's requirements and the plant's design conditions but the following guidelines shall be followed:

(a) Greased lubricated roller bearings for equipment with power ratings up to 100 kW.

(b) rolling element bearings for equipment with power ratings between 100 kW and 1 000 kW.

(c) White metal (oil-film type) bearings for equipment with power ratings above 1 000 kW and with high speed shafts. Bearings shall be provided with oil ring lubrication or positively fed lubrication.

The bearing housing design shall be such that rags and similar material cannot accumulate.

D24.3. Thermal Alarms

Thermal alarms on bearing systems shall be set in accordance with the specific instructions of the equipment manufacturer or, if it necessary for these to be set on Site, such alarms shall be set after no less than 24 hours of operation have occurred.

D24.4. Submersed Bearings

IP 57 shall be used for submersed bearings

Bearings, with the exception of ceramic bearings, which are located within the water level shall be provided with continuous greasing by a screened greasing unit in order to prevent ingress of grit. Lip seals, or similar, shall be provided in order to exclude grit and water, but to allow excess grease to escape.

The bearing housing design shall be such that rags and similar material cannot accumulate.

D25. LUBRICATION

D25.1. Grease Lubrication

The greasing system shall start and shall operate continuously whenever the equipment operates and shall stop when the equipment stop.

Where greasing points are not easily accessible, grease lines shall be piped to an easily accessible position for manual greasing. Each grease point shall be provided with completely separate pipework.

A distributor shall be provided where motorised lubrication is provided to more than one destination. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations.

Pipework and fittings for grease distribution shall be of stainless steel or non-ferrous metal (EN Grade 1.4401 316). Pipework supports shall be of stainless steel and shall be spaced at distances not exceeding 500mm.

A flow indicator shall be provided to allow visual confirmation of grease flow in the pipeline. This shall be provided as close to the bearing as is feasible for the application.

The grease container shall have a capacity of more than 1 kg and an indicator shall be provided to indicate the grease level. The container shall be easy to refill without stopping or affecting the operation of the pump. The pump shall be provided with a feature that will release any air trapped in the grease during filling.

A device shall be provided to allow the Operator to confirm the grease flow in the pipeline.

In channels, the pipe shall be cast into the concrete structure such that snagging of solids and also damage to the pipework is not possible. It is acceptable to protect the pipe by a shroud which is manufactured of 316 stainless steel, securely bolted to the concrete with 316 anchors of minimum diameter 16 mm and contoured in order to prevent snagging.

D25.2. Oil Lubrication

Where oil lubrication is provided, the Contractor is responsible for the initial oil fill and the first oil change, including flushing, draining and filling, after an initial run-in period not exceeding 3 months.

Oil level indicators shall be fitted for visual checking. Drain cocks, including 316 SS fittings where

[redacted]

necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1,5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall incorporate filters. Drain facilities shall always be provided.

D26. PUMPS

D26.1. SCREW PUMPS (Archimedes Pumps)

D26.1.1. Design Capacity

The duty required of screw pumps to be supplied is specified in the Detailed Mechanical Specification. Allowance shall be made in the design to permit the pump capacity (speed) to be increased by at least 20 % in the future should this be found to be necessary. Motors, gearboxes, couplings, vee-drives, shall accordingly be rated to suit such an increased duty.

D26.1.2. Design Details

Screw Pumps shall, in addition to the specific requirements given in the Detailed Mechanical Specification, comply with the following general requirements except as specifically agreed otherwise in writing by the Engineer:

(a) The central tube, end plates, shafts and fixing arrangements shall be designed to prevent distortion and fatigue in accordance with accepted standards of design. Stress calculations shall not include any allowance that might be claimed by the attachment of the flights to the centre tube or to buoyancy when the screw is lifting liquid.

(b) A width of at least 50 mm of the screw blade outer and leading edges shall consist of an approved corrosion and abrasion resistant material which shall be welded to the main part of the screw blade.

(c) Screw blades shall be evenly spaced and accurately machined to a cylindrical shape.

(d) Welding shall be carried out by the submerged arc or inert gas protected process.

(e) The concentricity of the diameter of the flights shall be within 5mm along the entire length of the screw.

(f) The concentricity of the stub shafts relative the outer diameter of the flights shall be within 5mm.

(g) The Clearance between the flight and the trough shall not be less than 1mm and not be more than 6 mm, along the entire length of the screw/trough combination when installed at any condition of the operation.

(h) Attachment of the flights shall be by continuous fillet welds on both sides of the flight plating interrupted where it intersects centre tube welds.

(i) Stub shafts shall have rounded inner corners at different diamaeters to limit stress concentrations.

(j) Stub shafts shall be readily removable for replacement.

(k) The fixing arrangements for stub shafts and end covers shall be air and water tight. All other joints, spigots, threads and crevices of any nature shall also be sealed during assembly using flexible sealants to prevent the ingress of water, moisture or air.

(l) The upper bearing shall be mounted on a rigid support frame.

(m) Components inside the building may be hot-dip galvanized and painted carbon steel, but all exposed metal to weather and liquid being pumped shall be grade 316 stainless steel.

(n) The upper bearing shall be designed to take the axial thrust and the applicable radial load. It shall be possible to easily dismantle and replace this bearing assembly without removing the stub shaft. Means for supporting and holding the screw pump while this is done shall be provided. The bearing arrangement shall be grease lubricated and fitted with seals on both ends.

(o) The bottom bearing shall be a sleeve bearing of the grease-lubricated, heavy-duty type mounted in a cast iron housing. The bearing shall be sealed against the ingress of liquids. The design shall be such that rags and similar material do not accumulate around the bearing. The bottom bearing shall be continuously grease lubricated by a

[redacted]

grease pump when the screw pump operates. The bearing and seals shall be easily removable.

(p) All fasteners and anchor bolts in the trough or exposed on the outside of the building shall be of grade 316 SS, or better, unless high tensile fasteners are necessary in which case they shall be painted as for the screw pumps.

(q) Each screw pump shall be direct coupled to a suitable gearbox through a flexible coupling with the gearbox vee-belt driven by a motor. It shall be noted that the gearbox will be mounted at an angle and shall be designed accordingly with the drive motor mounted horizontally.

D26.1.3. Grease Pump and Configuration

The grease pump for lubricating the screw pump's bottom bearing may be driven by the main screw pump motor or by a separate motor. In the latter case, the main screw pump motor must be so interlocked that it cannot operate unless the grease pump operates.

Suitable facilities shall be provided so that the grease pump can be used for priming the grease pipework without running the main screw pump motor.

The output from the grease pump shall be adjustable between maximum and zero. The amount of grease required by the bearing and the maximum output from the pump shall be stated.

D26.1.4. Grease Pipework

The grease shall be piped to the bottom bearing using 316L stainless steel tube or high pressure nylon tube with (316) stainless steel fittings. The tube shall be enclosed in a rigid polyethylene pipe duct which shall be installed down the side of the trough behind the splash plates.

D26.1.5. Corrosion Protection of Screw

The screw drum and blades shall be protected against corrosion by applying the System for Large Immersed Steel Fabrications (not requiring a decorative finish). The coating shall cover the abrasion and corrosion resistant material used on the screw blade outer and leading edges.

D26.1.6. Spares

The Detailed Mechanical Specification confirms whether the following spares are required:

(e) For each screw pump provided, one complete spare bottom bearing and all seals shall be provided. A spare bearing housing and pedestal is not required.

(f) For each screw pump provided, one complete spare top bearing and all seals shall be provided. A spare bearing housing and flange is not required.

(g) For each screw pump provided, at least ten bearing grease refills shall be provided for the operating staff to use during the 12 month Defects Notification Period.

D26.2. CENTRIFUGAL PUMPS

D26.2.1. Pump Duty

Details of pump duties are given in the Detailed Mechanical Specification and the type of pump and materials of construction shall at all times be selected to suit the fluid to be pumped and the performance requirements.

Pumps handling sewage and sludge shall be capable of running without choking, clogging, any liquid which may contain long fibrous material; vortex or open impellers are therefore preferred.

D26.2.2. Pump Type

Centrifugal pumps shall, wherever possible, be of the single-stage, end-suction, back pull-out type, direct-coupled to the motor using spacer type couplings and complete with common baseplate and guard. Close-coupled pumps may be used on clear water applications for motor sizes up to 2,2 kW.

D26.2.3. Pump Speed

Preference shall be given to pumps which operate at 1 500 rpm or lower. Pump speed and casing test pressures must be provided by the supplier.

D26.2.4. Performance Parameters

Performance characteristics shall be suitable for parallel operation with pump head increasing



continuously to shut off. The pump shall be selected to operate as close as possible to best efficiency at duty point and shall be adequately sized to safely permit an increase in capacity of at least 25 % should the head be lower than estimated.

D26.2.5. Margin of Power

A non-overloading absorbed power characteristic, preferably with maximum power absorbed at best efficiency, is preferred.

The motor's continuously rated power shall exceed the greater of the following:

(a) 10% above the maximum power demand under any condition of operation for the pump, including open discharge.

(b) 20% above the pump's maximum power demand over the full range of flow and pressure conditions anticipated in the pump installation.

D26.2.6. Impeller

Preference shall be given to pumps whose impeller diameter does not exceed 95 % of the maximum impeller diameter for the volute/diffuser provided. The impeller surface finish shall be up to N7. The peripheral speed of impellers should be designed not exceeding 10.5 m/sec.

D26.2.7. Lubrication

Unless otherwise specified in the Detailed Mechanical Specification, bearings shall be grease lubricated and adequately sealed against the ingress of moisture or dirt.

D26.2.8. Vibration

Rotating elements shall be adequately balanced.

D26.2.9. Pump Glands

Shaft sealing shall be arranged as follows:

(a) **For clear, non-aggressive liquids up to 200 kPa** discharge pressure - shaft sleeve with packed gland or mechanical seal.

(b) **For clear non-aggressive liquids at pressures above 200 kPa** and for clear corrosive liquids at any pressure - 316 stainless steel shaft sleeve with mechanical seal.

(c) **For liquids with solids in suspension at any pressure** – mechanical seal or packed gland with hardened and/or protected stainless steel shaft sleeve and grease seal. If a mechanical seal is specified, the pump gland shall be arranged to suit a clean water flush. A throttle bushing made of a suitable non-corrosive, self-lubricating material shall restrict the flushing water flow into the pump. Mechanical seals for such applications shall have silicon or tungsten carbide sealing faces.

D26.2.10. Venting

A vent cock shall be fitted to the highest part of the casing.

D26.2.11. Connections

Suction and discharge connections shall be flanged for pump connections larger than 40 mm.

Pump connections of 40 mm and smaller may be screwed. Unions shall be incorporated in the pipework close to the suction and discharge connections.

A flexible coupling shall be fitted close to the pump's suction connection.

D26.2.12. Isolating and Check Valves

Isolating valves shall be provided on the suction and discharge of all pumps. A check valve shall also be fitted between the discharge isolating valve and the pump except where reverse flow through the pump when stationary cannot occur. Any reducing necessary shall be done immediately next to pump connections.

D26.2.13. Pressure Tapping Points and Gauges

Pressure tapping points shall be provided near the suction and discharge connections of each pump. These points shall be located, where feasible, on a straight length of pipework where readings will be steady and accurate. Pressure (or suction, as applicable) gauges shall be fitted at these tapping points.

[redacted]

D26.2.14. Strainers

A centrifugal pump which draws from a tank or sump shall be protected by a strainer, suitably designed for the installation. The strainer shall be installed between a shut-off valve and the pump.

D26.3. SUBMERSIBLE AND IMMERSIBLE PUMPS

D26.3.1. General

Details of the duty and performance requirements of submersible and immersible pumps to be supplied are specified in the Detailed Mechanical Specification.

Pumps for sewage and sludge applications shall either be configured or shall be provided with a facility to prevent crusts forming on liquid surfaces as well as debris and sludge collecting on the sump floor.

Pumps must be provided with both suction and discharge pressure gauges.

D26.3.2. Submersible Pumps

Submersible pumps handling sewage, primary sludge, activated sludge or a similar product shall be of a non-chokeable type and shall be capable of handling a solid size of 100 mm diameter or greater. Impellers designed specifically for the application are preferred. These duties must be regarded as abrasive.

The motor shall be close-coupled to the pump and separated from the pump casing by an oil chamber. A mechanical seal shall isolate the motor from the chamber and a mechanical seal with tungsten or silicon carbide faces shall provide a shaft seal between the oil and the liquid to be pumped.

The motor shall be shut down automatically in the event of leakage into the oil chamber and as a result of overheating of stator windings.

Pumps required for abrasive duties shall be designed for low wear. Low operating speeds of 1000 RPM or less are preferred. The suction cover shall incorporate a replaceable volute liner of a suitable abrasion resistant material such as high chrome iron. The design shall permit easy adjustment of the clearance between the impeller and suction cover.

The shaft, all fasteners and all external steel components in contact with the pumped liquid shall be of grade 316 SS, or better. The pump and motor casing shall be of high-quality, close-grained cast iron. A suitable, heavy duty epoxy or polyurethane coating system with a minimum thickness of 400 µm shall be provided on the inside and outside of pump and motor casings.

D26.3.3. Immersible Pumps

Immersible pumps shall incorporate all features specified in Sub-clause "Submersible Pumps" above except that:

A suitable, heavy duty epoxy or polyurethane coating system with a minimum thickness of 250 µm shall be provided on the inside and outside pump and motor casings.

The motor for an immersible pump shall be provided with an integral jacket cooling system designed for non-immersed operation at full power. The cooling fluid shall inhibit corrosion and shall be self-contained; i.e. shall not rely on an external flow system. The cooling fluid shall not be the pumped liquid itself. Positive circulation of the cooling fluid within the jacket is preferred.

D26.4. DRAINAGE PUMPS

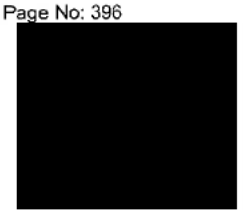
D26.4.1. General

This Clause applies to drainage pumps to be provided for applications involving seepage, slow leakage, sump discharge. Drainage pumps which are to prevent accidental flooding or other large inflows of water shall be specifically designed for the application by a pump engineer.

D26.4.2. Pump Type

Pumps shall be of the free-standing, submersible sewage, heavy construction, cast-iron type. Drive motors shall be three-phase units with oil bath and shall have protection to IP 68. The shaft shall be of stainless steel. Switching shall be done in accordance with liquid level by a float switch on cable (pivoting arms will not be acceptable).

D26.4.3. Installation



Drainage pump installations shall comply with the following:

(a) The discharge pipework shall be rigidly supported at a distance not exceeding 1 m. The discharge point shall be indicated by the Engineer.

(b) The discharge pipework shall incorporate a check valve on the initial upward run of pipework.

(c) The pump's discharge shall be connected to the discharge pipework via a clear flexible hose. It shall be possible to remove the pump and check valve without damaging the pipework.

(d) Discharge pipework shall be of uPVC, Class 12 or higher.

(e) The pipe cross section area of the outlet pipework shall not exceed 200% of the area of the pump outlet.

(f) Discharge pipework shall be sloped up away from the pump at all points apart from a single final straight run to the drain which may slope downwards at any angle.

D26.5. POSITIVE DISPLACEMENT PUMPS

D26.5.1. Type

Positive displacement pumps shall be suited to handle the fluids specified.

If the fluid to be pumped is sludge, it shall be noted that this contains solids, fibrous matter and grit. Construction materials shall be selected accordingly and the pump size shall be conservatively selected to ensure a very low operating speed. All universals, pins, bushes and so forth operating in the pumped liquid shall be properly lubricated and must be fully sealed.

D26.5.2. Duty

The pump duty will be specified in the Detailed Mechanical Specification.

D26.5.3. Drive Arrangement

Each pump shall be direct coupled to a motor/gearbox unit to suit the range of pump duties. The complete drive unit shall have an ingress protection rating of IP 55 or higher. The pump and drive unit shall be mounted on a common fabricated steel baseplate complete with all necessary guards.

All components shall be conservatively selected to suit the specified type of duty with continuous 24 hour per day operation. The continuously rated output of the motor shall exceed the power required at maximum duty and at the worst operating condition by not less than 30 %. The gear unit shall be selected using a service factor of not less than 2, based on the installed motor power.

If applicable, the unit must be prevented from reverse rotation.

D26.5.4. Variable Speed Drive

Pumps in variable speed applications shall have their drive motors controlled by variable frequency drives (VFDs) which are suitably rated for the torque required by the application. The VFD shall be housed in a cubicle in the electrical control panel which is normally in a separate room. The motor and VFD shall be of suitable design and shall be adequately sized to provide the high torque requirements of the pumps under all operating conditions, particularly start up.

D26.5.5. Drive Unit Protection

When pumping sludge, it is possible for the pumps to block or seize or have abnormally high starting torque requirements, particularly when operating on a duty/standby rotation basis. The complete installation shall be designed to cope with such operating conditions without damage to equipment.

The drive unit shall be rated to withstand such shock overloads at any torque produced by the motor between full speed and shock stall without any damage. **If any part of the unit could be damaged under such conditions, suitable safeguards shall be incorporated.** Thermal overloads on the motor shall not be regarded as adequate in such a case.

If an overload safeguard system is necessary to protect against overload damage, the system used shall disconnect the load immediately an overload occurs, switch off the unit, activate an

[redacted]

alarm indication on the control system and initiate the shutdown of other equipment if this is necessary. A sealed, adjustable and resettable torque limiting coupling between the pump and drive unit would be acceptable. The coupling must be set for the maximum torque which the drive unit can safely handle.

Full details of the drive system must be provided with the Tender.

D26.5.6. Pump Flushing System

A DN 50 connection shall be provided downstream of a check valve on the suction line of all pumps. A DN 50 flushing line from the domestic water supply, or the service effluent water system (if applicable), shall be connected to this. On each branch a solenoid valve, isolating valve, by-pass with isolating valve and check valve shall be fitted. This system shall automatically flush the pump before each start up and shut down. Manual flushing shall also be possible using the by-pass.

Where a system such as that described above is not possible on, for example, a direct feed hopper system, then an alternative flushing system such as a hopper flushing system shall be devised.

D26.5.7. Pressure Switches

Where pressure switches are used to protect pumps against closed or blocked lines by interrupting the supply to the motor, a pressure switch shall be mounted on the pump outlet and a vacuum switch shall be mounted on the pump inlet.

D26.5.8. Pressure Gauges

A suitably rated pressure or combination pressure/suction gauge shall be installed on the suction and discharge of each pump.

D26.5.9. General

The following shall be provided for each positive displacement pump:

(a) a suitably designed strainer on the suction side.

(b) a suitable check valve on the discharge pipework.

(c) protection against running against a closed discharge; i.e. discharge pressure switch or pressure relief valve.

(d) Protection against running dry; i.e. suction pressure switch, pump stator temperature switch or low flow signal from related flow meter.

D26.5.10. Peristaltic Pumps

The pump/motor/gearbox unit shall be configured so that the pump shaft is separately supported; i.e. the pump shaft shall be supported independently of the gearbox and the motor bearings.

Pumps with suction lines longer than 5 metres shall be provided with pressure pulse damping on the suction side.

Pumps with discharge pressures above 30 m pressure head shall be provided with pressure pulse damping on the discharge side. Diaphragm separation between liquid and air within the damper is preferred.

Hose breakage shall be monitored and the control system shall provide for automatic shut-down when a leak occurs.

Pump installations shall be provided with protection against a no-flow condition resulting from a shut valve or other blockage.

The conveying tube material shall be restricted to natural or nitrile rubber to resist loads and stresses induced.

D26.5.11. Spares

The Detailed Mechanical Specification confirms whether the following spares are required:

(a) For each progressing cavity pump installed, one spare rotor and one spare stator shall be provided as part of the Contract.

(b) For each peristaltic pump installed, one spare hose and ten complete hose lubricant fills as well as a complete set of tools for replacement of the hose shall be provided as

[redacted]

part of the Contract.

D26.5.12. METERING PUMPS

D26.5.12.1. Pumps

Metering pumps shall comply with the applicable design and installation requirements for positive displacement pumps but shall, in addition, comply with the following:

- Pumps which feature diaphragms shall be configured or protected so that diaphragm breakage will not lead damage to the internal part of the pump.
- All pump fasteners shall be of stainless steel.

D26.5.12.2. Pump Installation

The following requirements shall be provided for metering pump installations:

(a) Pumps shall either be mounted on a wall or other rigid vertical mounting surface or shall be mounted on plinths above ground level.

(b) Pumps shall be provided with an automatic pressure relief system in order to prevent overloading within the pump.

(c) Pumps shall be provided with check valves downstream of their discharge side

(d) The pipework on the inlet and outlet of pumps shall be provided with isolating valves and couplers to allow removal of the pumps without dismantling of the surrounding pipework.

(e) Strainers shall be provided upstream of the pump inlet. The strainers shall be designed and installed in a manner which will allow cleaning of the strainer element without uncontrolled spillage. Strainers shall be provided with inlet and outlet isolating valves.

(f) A facility for calibration of the pump shall be provided. This shall be sized to allow a minimum of one minute operating at full flow.

(g) A facility for connection of a flushing water pipe shall be provided. Permanently connected flushing water systems shall be provided where specifically called for.

(h) The piping in the vicinity of a metering pump shall be provided with a drain facility which shall be designed to minimise the amount of dosing fluid which would be lost during removal of the pump from the pipework.

(i) All mounting fasteners and mounting brackets shall be of grade 316 SS, or better.

D26.6. PUMP PERFORMANCE TESTING

D26.6.1. Performance Test

The pump units including the pump coupled to the motor, shall be tested at the manufacture's works in the presence of the engineer or his representative. The cost of carrying the work performance tests shall be deemed to be included in the overall cost of the plant. Tolerance limits and acceptable regulations shall be ISO 9906: Grade 1. The test results should be supplied to the Client Branches within two weeks.

Works tests includes:

(a) Balancing of the complete impeller and shaft at the manufacturers place

(b) Flow head curves shall be generated at the manufactures premises and checked against the manufacture's listed pump curves for any major discrepancies

D26.6.2. Testing On Site

The testing of the pumping plant shall be carried out strictly in accordance with ISO 9906 Grade 3 or according to the conditions of contracts where specified in the Detailed Mechanical Specification. During the testing of each unit careful examination will be important and the records are to be kept. The examination records should incorporate the following:

- Differential pressure rise across the pump
- Pressure (suction and discharge)
- Flow (instantaneous and totalized)
- Electrical power consumption

[redacted]

- Efficiency
- Bearing temperatures and vibration analysis

The pumping unit shall be calculated to determine whether these are in compliance with the guaranteed figures submitted by the contractor at the time of tendering.

After commissioning, checks should be carried out for proper functioning, direction and speed of rotation, and power consumption over the Trial Operation Period. Equipment performance will be considered acceptable when the requirements as specified have been met consistently during test period. The performance of the equipment shall be examined and tested at 1, 3, 6, 9 and 12 months intervals during Defects Notification Period. At each test intervals performance reports including items of examination should be submitted to the engineer.

D27. VERTICAL SHAFT MIXERS/AERATORS

D27.1. General

Suitable mixers shall be chosen for the liquor to be mixed. This applies to both the design of the mixing action for the percentage total dry solids and to the choice of motor and gearbox rating.

Motor and gearbox ratings for continuous operation shall provide a 20 % margin higher than the maximum mixer shaft input requirement.

Vertical shaft mixers shall incorporate stainless steel shafts and impellers. Suitable means of removing and re-installing the mixers during normal operation shall be provided.

The mixer impellers shall be designed to prevent rag fouling.

D27.2. Mounting

Mixer motors and gearboxes shall be mounted on rigid, boxed baseplates which shall be secured using a minimum of four, 16 mm anchors.

The bottom end of the shaft shall incorporate a suitable polymer bearing, incorporating a stainless steel housing bracket, to limit radial deflection of the shaft.

D27.3. Motors

Motors shall feature a cowl, or similar device, which shall be designed to prevent rain reaching the motor shaft.

D27.4. Mixing Design Requirements

In general the mixers are required to thoroughly mix the contents of the tank or chamber, to keep solids in suspension throughout the volume and to prevent a crust forming on the surface.

The mixers shall be sized to maintain an effectively constant suspended solids concentration throughout with not more than 200 mg/ℓ variation from the average at any point in the tank.

In sewage sludge reactor basins, this mixing efficiency must be achieved at activated sludge solids concentrations up to 5 000 mg/ℓ and bulk settling velocities up to 5 m/hr.

The mixers/aerators should function by moving a large volume of water in a range of more than 50 liters per second. They should measure a maximum of more than 1 meter into the air, to enable gas transfer within the tank, inducing circulation and improving water quality. The immense amount of water being propelled into the air and splattered back down onto the water surface, a wave action is spread out outward from the unit to the direction of the tank perimeter. The tip speed of the impeller at 50Hz should not be more than 5 m/s.

Aerators: preference should be given to low rotational speed of turbines. For aerators having a driving motors of over 30 kW the maximum rotational speed shall not exceed 40 rpm and smaller kW motors the velocity shall not exceed 50 rpm.

The mixers shall be of Axial Flow design and be built from robust construction and protected against corrosion.

D27.5. Mixing Performance Tests

The mixer units including the impeller coupled to the motor, shall be tested at the manufacture's works in the presence of the engineer or his representative. Mixing performance testing shall be as for "Pump Tests".

The Contractor will be required to test the performance of the mixers when commissioning the

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plant. This test shall consist of taking a minimum of six samples at random points close to the surface and from the bottom of the compartment within five minutes. Duplicate analysis of these samples for suspended solids concentration will then be carried out in a suitable laboratory and the average concentration calculated. The suspended solids concentration of any one sample shall not differ from this average by more than 200 mg/ℓ.

If the equipment fails to pass this performance test, a second test may be carried out. If the mixers still fail the test, the Contractor shall increase the mixing capacity of the equipment and shall achieve compliance with the performance requirements at no additional cost to the City of Cape Town.

D28. SUBMERSIBLE MIXERS

D28.1. General Requirements

Suitable mixers shall be chosen for the liquor to be mixed. This applies to both the design of the mixing action for the specified percentage total dry solids and to the choice of motor and gearbox rating.

Motor and gearbox ratings for continuous operation shall provide a 20 % margin higher than the maximum mixer shaft input requirement.

Details of the mixer application are given in the Detailed Mechanical Specification.

The mixers shall be submersible with a propeller integrally mounted on a submersible motor. The motor shall be separated from the propeller by an oil chamber. A suitable seal shall isolate the motor from the oil chamber and a mechanical seal with tungsten carbide faces shall seal the oil chamber from the mixed liquid. If the mixer incorporates a gearbox an additional seal shall be provided to isolate the gearbox oil system.

The mixers shall automatically shut off in the event of water contamination of the oil, loss of oil, excessive stator temperature, earth leakage or motor overload and suitable probes and switches shall be provided.

Each mixer shall be provided with one flexible cable to accommodate all the required connections within the machine. Cable lengths shall be provided to suit Site requirements but a minimum length of 7 metres shall be allowed for. No joints will be acceptable.

For sludge applications, propellers shall be of a type suitable for handling stringy solids and thick sludge and shall preferably not require a shroud. The motor shall be of adequate size to perform the required duty with sewage sludge having a dry solids content of over 6 % by weight unless otherwise specified.

The mixer body shall be of rugged cast iron or of stainless steel construction. Cast iron shall be coated with a heavy duty epoxy corrosion protection system at least 300 µm thick. If a shroud is necessary this shall be ruggedly and rigidly fixed with it and all brackets being made of a non-corrosive material. The mixer impellers shall be designed to prevent rag fouling.

Each mixer shall be mounted with a sliding bracket on a guide column fixed to the floor of the tank and at the top of the tank with a suitable bearing or turntable. It shall be possible to rotate the mixer through an angle of 180° while the mixer is operating and to fix the direction and height in the position selected. The guide column shall extend above the walkway level to suit the specified lifting arrangements.

The operating cross bars or handles, the locking arrangement and the fixing arrangement shall not intrude into any walkway and shall not present a hazard in any way. If necessary, operating levers shall be easily removable.

If variation in mixer inclination in the vertical plane is required, the Contractor shall design accordingly.

Suitable lifting arrangements shall be provided for removing each mixer. The general design of the sliding bracket and lifting arrangement shall allow one man to lift the mixer without any jamming, wedging or sticking.

Guide columns, support brackets, etc., shall be of hot-dip galvanized low carbon steel (and painted as specified) or of 316L stainless steel. All fasteners, guide pins, turntables, bearings, fixing pins, chains, pivot pins, etc., shall be of 316L stainless steel or, where applicable on items such as bushes, of non-corrosive materials.

Where the mixers are required to operate in sumps or other containers in which the level varies, the mixers shall be designed and arranged to permit the lowest operating level and Tenderers shall state the minimum submergence required. Level controls shall be provided to stop the mixer at the lowest level and restart again at a suitable higher level (except as otherwise specified in the Detailed Mechanical Specification).

D28.2. Mixing Design Requirements

Mixing design requirements shall be as for "Vertical Shaft Mixers".

Mixing performance testing shall be as for "Vertical Shaft Mixers".

D29. COMMINUTORS/MACERATOR

The following item is not widely used in the City any longer due to:

- The sewage network contains huge amount of sand which increases the wear of the Comminutors.
- The wear of blades as described above also has a negative effects on Bio-Reactors.

D29.1. General

"Comminutors" are cutting devices which act as a screen and are designed to either cut solids which are larger than the screen openings or to block the solid, stop and activate an alarm.

D29.2. Type of Solids

The solids to be handled consist of the usual solid matter found in sewage and include grit, cotton waste, rags, stockings, plastic bags, paper, seeds, and so forth. The comminutor must also be able to cope with hard and tough materials such as wood, leather, canvas, plastic and metal containers, metal bottle tops and so forth without serious damage to the unit or its cutting surfaces.

The effective screening gap shall be 6 mm or less.

D29.3. Design of Comminutor

The comminutors shall be of a slow speed, high torque design suitable for the duty conditions. Two shafts carrying toothed cutting discs shall operate at different speeds.

Cutting surfaces shall be manufactured of corrosion resisting steel having a surface hardness of not less than 50 HRC.

Casings shall be of cast iron and shafts shall be of a corrosion resistant, high quality alloy steel.

Bearings shall be of the roller or ball type, grease lubricated and efficiently sealed by mechanical seals with tungsten carbide faces. Tenderers shall advise whether any seal flushing arrangement will be required.

Greasing shall be possible whilst the unit is operational and shall comply with the sub-clause "Grease Lubrication".

The drive shall be vertically arranged through a close coupled gearbox with all components adequately rated for a stall condition. The motor shall be mounted clear of all fluid flow.

D29.4. Installation

The configuration of units installed in channels shall ensure that grit cannot collect at the cutting surfaces; i.e. comminutors shall not be installed at low points in the channel.

Comminutors which are installed in-line shall be mounted on a vertical length of pipework with the flow upwards.

D29.5. Control System

The motor size shall be sufficient to permit cutting of any object which will not damage the cutting surfaces or the unit itself. Once an excessive level of power is approached, however, the control system must try to clear the machine by reversing. If this is not successful in clearing the machine, both the comminutor and any in-line equipment shall shut down, sound an alarm and activate an alarm on the control system.

D29.6. Corrosion Protection

Cast iron components shall be protected by applying the System for Large Immersed Steel

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Fabrications (not requiring decorative finish); i.e. polyamine/amide cured coal tar epoxy, or similar approved coating, shall be used on all cast iron components. Non-corrosive materials shall be used wherever possible.

D30. SCREW CONVEYORS

D30.1. General

Details of the duty, performance and any other requirements for screw conveyors to be supplied will be given in the Detailed Mechanical Specification.

Screw conveyors shall comply with the following:

(a) Conveyors shall be conservatively sized and shall be suitable for handling at least 35 % in excess of the maximum duty specified in the Detailed Mechanical Specification. The conveyor shall also be designed to operate well within the maximum design limits for the type of duty specified.

(b) The capacity of a receiving conveyor shall be at least 5 % higher than its supply conveyor.

(c) Conveyors must be suitable for operating at any duty between no load and full load, either wet or dry, 24 hours per day.

(d) Conveyors shall be of rigid construction and shall be designed for a life before major repair of not less than 10 000 hours. Each unit shall operate quietly and without spillage or leakage. Protection, such as motor overload protection, shall be provided against damage from blockage or jamming.

(e) All radial and thrust loads shall be taken by the screw bearings and shall not be transmitted to the driver.

(f) All greasing points shall be piped to a convenient accessible position for manual greasing. The system shall provide positive lubrication of each point either using separate lines or, if the lines are manifolded, a positive displacement grease distributing device shall be provided (Woerner, Lincoln or equivalent).

(g) The conveyor shall be driven by direct-coupled motor and gearbox. Couplings shall be of the rubber tyre type with taperlock bushes keyed to the shaft. Guards shall totally enclose the drive.

(h) Conveyors shall be designed for resistance to corrosion. All fabrications such as shafted screws, troughs and covers, supports, guards, etc., shall be manufactured from 304L SS, 316L SS, or EN 1.4162. All shafts, pins, fasteners, hangers, sleeves, bushes, rollers, gland followers and other small items shall be made of grade 316 SS, or better, or of another equally non-corrosive material. On proprietary items such as motors, gearboxes, couplings, sprockets, etc., particular care shall be taken to apply suitable protective coatings. Welding shall be continuous all round to prevent any crevices and all bolted and other mating faces and mounting pads shall be sealed during assembly with a suitable non-hardening sealer.

(i) Trough covers shall be provided. These shall be light and easily removable but rigid and strong and shall be of a non-corrosive, UV-resistant material. Covers shall be hinged for inspection purposes and to serve as a relief in the event of blockage in the following positions:

- at the discharge point and
- along the entire screw axis;
- near the inlet.

(j) Trough liners shall be designed to allow easy replacement of the liner without damage to the trough structure..

(k) Sharp edges on items fabricated from thin sheets will not be acceptable and such sharp edges shall preferably be eliminated by design.

D30.2. Centreless Screw Conveyors

In addition to the general requirements for screw conveyors, centreless screw conveyors shall comply with the following:

(a) The plate thickness used for the helical screw shall be at least 20 mm.

(b) The liner on which the spiral rests shall consist of a polymer featuring a two-colour laminate designed to act as a wear check. Thickness of the liner shall be at least 10 mm. The preferred ratio of the two-colour laminate is 7:3.



(c) The complete body shall be of grade 316 SS, of EN 1.4162, or better. It is not a requirement that the screw is of stainless steel.

(d) The drive motor shall preferably be mounted at the high point of the conveyor.

D30.3. Shafted Screw Conveyors

In addition to the general requirements for screw conveyors, shafted screw conveyors shall comply with the following:

(a) The conveyor screw shall be kept clear of the trough and shall be supported at both ends by rollerbearings. These bearings shall be totally enclosed in coated cast iron or stainless steel housings which shall be adequately sealed against the ingress of moisture and dirt and shall be mounted external to the trough.

(b) The upper bearing of inclined conveyors shall be the thrust bearing and the bottom bearing shall be mounted clear of the trough and cover. The shaft through the bottom cover shall be sealed by means of a gland incorporating at least one throttle bush, a lantern ring, at least three rings of packing, a positively driven, "Stellited", 316 SS, slip fit shaft sleeve with o-ring seal and 316 SS gland follower. The gland shall be grease sealed or water flushed depending on the application.

(c) The centre tube shall preferably be rigid enough to avoid the use of intermediate bearings. Where the use of intermediate bearings cannot be avoided, they shall be supported by suitable hangers which will not interfere with the flow of the product being conveyed. The screw shall also be sized so that the bearing is not immersed in the product being conveyed. The bearings shall be completely sealed in a manner suitable for the application and shall be grease lubricated. A maintenance hatch shall be provided at the hanger.

(d) Provision shall be made in the conveyor design for easy replacement of items such as end bearings, intermediate bearings, throttle bushes, shaft sleeves, coupling tyres, chains, etc., without excessive disassembly and without removal of the complete unit. The general arrangement shall permit convenient access to all parts of the unit and shall permit easy installation or removal.

(e) Where appropriate, the screw conveyor shall be designed for abrasion resistance. All applications handling grit or sludge shall be regarded as highly abrasive. The conveyor shall be designed for slow speed and very low rubbing velocities. Outer edges of the conveyor screws shall be manufactured of, or lined with, an abrasion and corrosion resisting material. The trough shall be completely lined using conveniently replaceable 1 m long sections made of a corrosion and abrasion resistant material. Alternatively the trough shall be lined to a minimum thickness of 6 mm with a repairable material suitable for the particular application such as neoprene, polyurethane, ceramic lining compound, etc. Full details of the manufacturer's proposals shall be provided with the Tender.

(f) The screw shall be fabricated from plate with a thickness of not less than 6 mm. Acceptable materials are specified above.

D30.4. Spares: Screw Conveyors

The Detailed Mechanical Specification confirms whether the following spares are required:

- Trough liner.
- Screw.
- Complete set of screw bearings.

D31. BELT CONVEYORS

D31.1. Design

The design, manufacture and application of the conveyor shall comply with Conveyor Equipment Manufacturer's Association (CEMA) Standard No. 402. Conveyor components shall comply with SANS 1313, SANS 1669 and SANS 1366, all as applicable.

The conveyor shall be of the troughed belt type running either on non-corrosive troughing idlers or on a stainless steel slider bed as recommended by the Contractor. It must also be noted that the loading on the belt could be relatively low and the conveyor would be operating in a very moist and corrosive environment. During operation all idlers shall rotate freely.

D31.2. Conveyor Belt

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The belt width shall suit the duty but shall not be less than 450 mm with at least 2 plies, and with 1,5 mm minimum thickness of covering to both sides. The belt shall be of a neoprene or other material unaffected by moisture or substances normally expected on a sewage application. Alternatives may be offered. Vulcanised splicing shall be used. The use of clips will not be allowed. Belt speed shall not exceed 30 m/minute.

D31.3. Guards

The conveyor shall be so enclosed that all moving parts and nip points are neatly and safely guarded. The head and tail pulley's shall be as safely guarded as possible without causing a hindrance to the operation of the conveyor. Where exposed, the sides and bottom of the conveyor must be covered with corrosion resistant and easily removable panels small enough to handle in a strong wind.

D31.4. Splash Boards

On screenings duty, the Conveyor shall be provided with suitably protected 20 mm thick hard wood or 8 mm polypropylene, angled splash boards not less than 300 mm wide along both sides of the belt and firmly secured to the conveyor frame along its entire length. The bottom edge of the splash boards shall be provided with a rubber skirt which shall be adjustable and adjusted so that clearance between the skirt and conveyor belt is kept to a minimum. The splash boards shall be so designed and installed as to assist with clean and trouble free loading and discharge of material.

D31.5. Emergency Trip Wire

An emergency trip wire and cut out switch must be provided. The trip wire must extend along the entire length of the conveyor on both sides.

D31.6. Belt Scraper

A belt scraper, either reinforced neoprene or neoprene bladed shall be incorporated below the head pulley designed to remove screenings of a fibrous and sticky nature. The scraper shall be designed to be well clear of the discharge point and not provide collection points for screenings. Pressure between the belt and the scraper shall be maintained by suitable rubber filled torsion holders. The torsion holders shall be mounted on adjustable stainless steel screw type mountings positioned well clear of the discharge from the conveyor.

D31.7. Idlers and Pulleys

Idlers shall be of a non-corrosive abrasion resistant material. All idlers shall have pre-lubricated sealed for life roller or ball bearings and details of the bearing sealing arrangement shall be provided with the tender. Head and tail pulleys shall be crowned and shall be fabricated of 316 SS or shall be of cast iron or carbon steel and neoprene coated in both cases. Pulleys shall have a minimum diameter of 250 mm and be fitted with taperlock bushes. Shafts shall be of 316 SS, or better, and adequately sized and bearings selected for an L_{10} life of 100 000 hours.

All idlers must be mounted in such a way as to facilitate easy removal and replacement.

The pulley shafts shall be supported by spherical roller bearings. The bearings shall be mounted in cast iron bearing housings. Bearing housings shall fully enclose the bearing and open type integral bearing units are not acceptable even if shielded bearings are used. All bearing housings shall be sealed and fitted with grease points piped to a convenient easily accessible block on which nipples shall be fitted. Individual grease pipes shall be provided or, alternatively, positive displacement distribution blocks shall be fitted.

"Take ups" or the "tensioning pulley" shall be of the protected screw type with a minimum adjustment range of 350 mm. The screws are to be of grade 316 SS, or better.

D31.8. Slider Beds

If used, slider beds shall be of 3CR12 or grade 316 stainless steel not less than 6 mm thick and painted with an approved 3 coat polyurethane paint system. Slider beds shall also be designed so as to be easily replaceable. The slider bed trough shall be open along the centre so as not to provide a collection area for liquids or dirt.

D31.9. Framework

The supporting framework shall be of rigid welded or bolted construction. Tubular construction will not be accepted. All welding shall be continuous and no unwelded or unsealed crevices shall be permitted. All idlers must be mounted in such a way as to facilitate easy removal and

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replacement. The corrosive nature of the environment must be noted and all steel work shall be hot-dip galvanized (or hot-metal zinc-sprayed or hot-metal aluminium-sprayed) and painted.

D31.10. Drive

The drive unit shall preferably be of the shaft mounted torque arm gearbox type with motor and gearbox being a combined unit, and mounted directly on the drive pulley shaft. The gearbox shall be selected for continuous operation with a power service factor of not less than 1.5. All bearings shall be designed for an L_{10} life of not less than 100 000 hours. A sight glass for observing the oil level shall be provided and shall be of a type which cannot be easily broken accidentally. Tenderers shall allow for initial fill of lubricants and for draining, flushing and refilling after an initial bedding in period of not longer than 3 months. Although a shaft mounted direct coupled arrangement is preferred, a chain or belt drive shall comply in all respects with the requirements of this Specification. Jacking screws must be provided for tensioning the drive and a movement of at least 50 mm in each direction must be possible. These screws shall be of grade 316 SS, or better.

D32. COMPRESSORS

D32.1. General Requirements

Each compressor shall be provided with:

(a) isolating valve.

(b) check valve.

(c) lockable pressure relief valve (this shall be in addition to any fitted to air receivers).

(d) discharge pressure gauge.

(e) inlet pressure gauge (if the inlet pressure is not atmospheric).

(f) air intake filter (of the efficient, heavy-duty, dry-type air filter incorporating a centrifugal pre-cleaner with automatic dust ejector, a renewable filter element or cartridge and a servicing indicator).

(g) inlet and outlet silencers.

The volume of air delivered by a compressor shall modulate to match the demand. Provision shall, however, be made for the compressor to shut down should there be no air demand for a predetermined period, and to restart when demand is re-established. During the period before the compressor stops, the compressor shall be arranged to operate in a low power demand, idling mode.

D32.2. Rotary Compressors

Compressors shall be of the air-cooled, rotary type, either directly coupled to, or vee-belt driven by an electric motor, and shall be mounted on a rigid fabricated steel base plate and fitted with suitable guards. Preference will be given to low speed units, and the size of unit shall be conservatively selected.

A final automatic filter drain to remove any trace of oil and water is to be provided.

When an oil separator vessel is needed, this will probably be classified as a pressure vessel and the requirements of the clause "Air Receivers" shall apply. Handholes will not, however, be required where the diameter of the separator is too small. OHS Act requirements shall be complied with and shall take precedence.

The sound level at a distance of 1 metre from the compressor at any operating point shall not exceed 80 dBA.

D32.3. Silenced, Package Type Rotary Compressors

Silenced compressors shall be of the air cooled, rotary type complying with the noise limit of 70 dBA at one metre. In order to achieve this, the compressors shall be of the packaged type mounted in a soundproofed enclosure on anti-vibration mounts with the machine adequately silenced.

All necessary controls and instruments shall be integrally mounted with the compressor enclosure and shall comply with the electrical specifications.

All relevant and necessary check valves, minimum pressure valve, air/oil filters, etc., shall be

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fitted to the unit.

D32.4. Reciprocating Compressors

Reciprocating compressors may be used for workshop applications where the compressor can be installed externally and the higher noise and vibration levels can be tolerated.

D33. AIR RECEIVERS

Wherever possible, only South African manufactured construction materials shall be used for air receivers which shall be of heavy gauge steel with convex ends, shall be of welded construction and shall be manufactured to a code acceptable to the Department of Manpower Utilisation. This Code of Manufacture shall allow for two elliptical handholes with oil resistant gaskets, one at each end of the cylindrical section, as per drawing No. ME A4/1519 (see Clause "Standard Drawings") and the handhole covers shall be spigotted to facilitate accurate positioning. Screwed inspection plugs will not be acceptable. A Government authorised inspection authority shall, in addition to the duties laid down in the relevant Code of Manufacture, inspect the design, construction and materials of all handhole covers and the clamping arrangement. These covers and clamps shall be stamped and certified and the maker's certificate shall be endorsed accordingly.

The vessels shall in all respects comply with the requirements of the applicable regulations of the Machinery and Occupational Safety Act of 1983 and each vessel shall include the following:

(a) A pressure gauge of not less than 150 mm diameter, calibrated in kPa and redlined at the maximum safe working pressure. The calibration scale shall not exceed twice the safe working pressure of the vessel or be less than the hydraulic test pressure of the vessel.

(b) Lockable safety valves complete with bronze padlocks and two keys.

(c) Automatic drain valve cock (the drain for condensate removal must be at the lowest point of the receiver, a syphon type drain is not acceptable). Particular attention must be paid to the contouring of the weld at the drain cock to ensure that no condensate can be trapped within the vessel. The draincock shall be piped to a drain.

(d) An isolating valve in each air supply line as close as possible to the air receiver which it controls.

A maker's Test Certificate for the air receivers as required in terms of the Machinery and Occupational Safety Act, 1983 as amended, showing the hydraulic test pressure, must be supplied. This Test Certificate must be signed by a Government authorised inspection authority. The Contractor shall also arrange for the receivers to be tested and inspected in accordance with the above Act after installation and before being put into use for the first time. This test shall be witnessed by the Engineer or a competent person delegated by him.

All hot pipework which constitutes a hazard to operators shall be insulated.

The vessel shall be painted externally in accordance with System for non-Immersed Steel in Moderate Atmosphere and unpainted internally.

D34. PRESSURE VESSELS

All aspects of pressure vessels installations, including design, fabrication, installation, ancillary equipment, etc., shall comply in all respects with the appropriate parts of the Vessels Under Pressure Regulations, 1996 forming part of the OHS Act & Regulations. Pressure vesseis shall be of welded construction and shall be manufactured to a code acceptable to the Department of Manpower Utilisation. Screwed inspection plugs will not be acceptable.

The vessels shall in all respects comply with the requirements of the applicable regulations of the Machinery and Occupational Safety Act of 1983 and each vessel shall include the following:

(a) A pressure gauge of not less than 150 mm diameter, calibrated in kPa and redlined at the maximum safe working pressure. The calibration scale shall not exceed twice the safe working pressure of the vessel or be less than the hydraulic test pressure of the vessel.

(b) Lockable safety valves complete with bronze padlocks and two keys.

(c) A maker's Test Certificate for the pressure vessels as required in terms of the Machinery and Occupational Safety Act, 1983 as amended, showing the hydraulic test pressure, must be supplied. This Test Certificate must be signed by a Government authorised

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inspection authority. The Contractor shall also arrange for the pressure vessel to be tested and inspected in accordance with the above Act after installation and before being put into use for the first time. This test shall be witnessed by the Engineer or a competent person delegated by him.

The required corrosion protection system shall be System for non-Immersed Steel in Moderate Atmosphere unless specified otherwise in the Detailed Mechanical Specification.

D35. BLOWERS AND VACUUM PUMPS

D35.1. General

Each blower shall be provided with the following:

(a) Isolating valve.

(b) Pressure relief valve sized for full flow.

(c) Check valve.

(d) Inlet filtration with paper element.

(e) Inlet and outlet silencing.

(f) Discharge pressure gauge.

(g) Inlet pressure gauge (if not atmospheric).

(h) Anti-vibration mounts.

Roots type rotary lobe blowers shall be installed and configured so that the suction and discharge pulsing is minimised and shall not cause undue noise or damage to equipment.

The Detailed Mechanical Specification describes the requirements for the sealing water supply arrangement for liquid-ring units.

D35.2. Pressure Relief Valve

A lockable pressure relief valve shall be fitted to **each** unit, regardless of whether any electronic protection system has been provided.

The pressure relief valve shall be sized for full flow at blow-off pressure. It shall be mounted immediately downstream of the blower but upstream of any valve. Unless provided as part of a proprietary package, the valve shall be mounted on a flanged nozzle on the discharge pipe. A padlock, or equivalent locking mechanism, shall be provided.

The valve shall be provided with a test certificate indicating the blow-off pressure setting.

D35.3. Liquid-Ring Units for Wastewater Applications

Liquid-Ring Units for wastewater installations shall incorporate stainless steel impellers and bodies.

D36. COOLING TOWERS

Cooling towers shall be rated to suit the cooling duty calculated from or specified in the Detailed Mechanical Specification.

Cooling towers shall be of the induced draught counter flow design. Construction shall be of corrosion free and UV resistant materials such as fibre glass, with all metal components including fasteners of 316 SS, or better.

The cooling towers will be exposed to the very strong winds common in this area and must be designed to eliminate spray drift.

A large water reservoir must be provided in the bottom of the tower which shall be provided with a float valve for make-up water, and connections for overflow, drains and take off.

D37. LIFTING EQUIPMENT

D37.1. General Requirements

Lifting equipment shall comply with the following general requirements:

(a) The design, fabrication and installation of lifting equipment shall be fully in accordance with the relevant aspects of the Occupational Health and Safety Act and Regulations.

[redacted]

(b) Lifting equipment shall be designed, constructed and installed in accordance with an internationally accepted technical design standard.

(c) Where applicable these standards will be implemented, SANS 1599.

(d) The guidelines given in the Southern African Steel Construction Handbook may be used where applicable and where these do not conflict with the internationally accepted technical design standard.

(e) Test certificates shall be provided for all items of lifting equipment.

(f) The safe working load (SWL) shall be permanently marked on all items of lifting equipment.

(g) Lifting equipment and installations shall be inspected and shall be tested over the complete lifting range using a test load.

Unless otherwise specified in the internationally accepted technical design standard, the test load shall be:

- at least 125 % of the SWL for equipment with a SWL of up to 10 tonne SWL;
- at least 110 % of the SWL for equipment with a SWL of 10 tonne and above.

(h) High-tensile and alloy steel chains shall have a factor of safety of at least four. Other chains shall have a factor of safety of at least five.

(i) Steel-wire ropes shall have a factor of safety of at least six. Man-made fibre ropes or woven webbing shall have a factor of safety of at least six. Natural fibre ropes shall have a factor of safety of at least ten.

(j) Anchor fasteners for securing steel structures to concrete shall have a diameter of not less than M16 and shall be of grade 316 SS, or better.

(k) Foot-plates for columns which form part of lifting gantries shall be secured with a minimum of four anchor bolts.

(l) Hollow steel sections such as pipes and tubing are not acceptable as structural members unless the section is fully closed by welding.

(m) Tenderers shall note that many aspects, such as fabrication, welding, corrosion protection and fasteners, shall be in accordance with the requirements of other clauses in this Standard Specification for Mechanical Works.

D37.2. Steel Gantries

In addition to the general requirements for lifting equipment, steel gantries shall comply with the following:

(a) The same internationally accepted technical design standard used for the design of the crawl beam or crane shall be used for designing the gantry which supports the crane or crawl beam.

(b) Columns shall be cross-braced and/or "triangulated" in more than one plane. In other words, columns shall not be cantilevered in any vertical plane.

(c) Gantry steelwork shall be hot-dip galvanised. If this is not feasible, steelwork shall be hot-metal zinc-sprayed, sealed and coated in accordance with the clause "Corrosion Protection : Metal Coatings".

D37.3. Overhead Travelling Cranes

In addition to the general requirements for lifting equipment, overhead travelling cranes shall comply with the requirements below.

D37.3.1. General

Construction of the crane shall be in accordance with BS 466 and BS 2573 (or BS EN 13 001), as applicable. All welding of steelwork shall be carried out in accordance with BS EN 1011 by competent artisans meeting the requirements of BS 4872. (Suitable equivalent standards are acceptable SANS)).

Design requirements for the fixing and installation of the crane rails shall be provided by the Contractor to the Engineer for acceptance.

D37.3.2. Certificate

[redacted]

The Contractor shall supply to the Engineer a certificate from the crane manufacturer which:

(a) certifies that the crane has been manufactured in accordance with the requirements of the Driven Machinery Regulations of the Occupational Health and Safety Act;

(b) specifies the internationally accepted technical design standard used, and;

(c) states the SWL and the test load.

This certificate shall be provided to the Engineer prior to delivery of the crane to Site.

D37.3.3. Configuration

The overall configuration shall be as follows:

(a) the crane hoist shall be supported on and travel along a steel crane beam structure.

(b) the crane beam shall be supported on end carriages which travel along crane rails.

(c) the crane rails shall be supported along their full length, either on a concrete beam or on a hot-dip galvanised steel beam structure.

The crane long travel, cross travel and hoist shall be electrically-powered or manually operated as stated in the Detailed Mechanical Specification.

Unless otherwise stated:

(a) the lowest hook level shall be floor level.

(b) electrical control pendants shall be arranged to move independently along the length of the crane beam and shall be situated at one metre above floor level.

(c) the operating chains of manually operated cranes shall fall to one metre above floor level.

D37.3.4. Construction

All materials shall be new and unused and suited to the application. Structural steelwork shall comply with the requirements of SANS 1431 and the grade used for structural members shall be 300 WC.

The crane rails shall be standard rail sections. Rails manufactured from square section steel bar will not be acceptable. Rail lengths shall be joined using fish-plates, with at least four fasteners, to provide a continuous path for the travel of the crane wheels.

The crane beam and end carriages shall be designed with suitable dimensions, wheel spacings and gusset plates or diagonal bracing to prevent cross-whipping.

End stops with rubber buffers shall be fitted to prevent the hoist from moving off the travelling beam. Stops and buffers are also required to limit the long travel on the rails.

Lubrication systems shall be designed to exclude dirt and moisture and all gear wheels shall be fully enclosed.

Bearings shall be mounted in sealed, cast iron bearing housings or in totally enclosed and sealed housings, grease-lubricated and provided with grease nipples in both cases. The open type bearing units with exposed "lubricated for life" bearings will not be acceptable.

D37.3.5. Installation

The crane and rails, when erected and installed, shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. The crane rails shall be straight to within the permissible deviations given in BS 466 over their entire length.

The distance between rail supports shall not exceed 1 000 mm. Every rail length shall be supported at both its ends.

Crane rail anchor fasteners shall be M16 or larger and shall be of grade 316 SS or better.

The full length of the rails shall be grouted in cases in which the rails rest on a concrete beam. A suitable gap between the rails and the beam shall be provided for application of the grout. The grout shall be applied strictly in accordance with the manufacturer's instructions. The grout shall be neatly finished with a 45° chamfer. The Engineer shall be notified prior to application of the grout.

In the alignment of equipment or structures, the use of multiple shims will not be permitted.

[redacted]

Shimmed feet shall be fully grouted to provide corrosion protection of the shims.

Grouting shall be done using a non-shrink cementitious grout, ABE Duragrout 1000 or equivalent, to the approval of the Engineer and in accordance with the manufacturer's instructions.

D37.3.6. Maintenance Platform and Ladder

Where specified in the Detailed Mechanical Specification, a maintenance platform for two people shall be provided along the length of the crane beam.

The crane beam structure shall incorporate welded lugs onto which the platform shall be bolted; i.e. the platform shall be removable and shall not be welded to the crane beam. The complete platform and all guard-railing shall be hot-dip galvanised after fabrication. The platform floor shall have a minimum width of 500 mm.

Guard rails shall be provided on the maintenance platform and shall comply with the clause "Guard Railing".

Where specified in the Detailed Mechanical Specification, a hot-dip galvanised fixed steel ladder shall be provided at a suitable position within the building for accessing the platform on the crane. This shall comply with Clause "Permanent Ladders and Stairs".

D37.3.7. Hoists

In addition to the general requirements for lifting equipment, hoists shall comply with the following:

(a) Hoists shall be provided with an overload prevention device; e.g. a clutch which slips upon overloading. Powered hoists shall comply in all applicable respects with Driven Machinery Regulation 18 of the Occupational Health and Safety Act.

(b) Powered hoists shall hold the load stationary upon power failure.

(c) The bottom hook shall swivel on a ball or roller bearing through 360° and the bearing shall have a protective skirt. The hook shall be fitted with a safety latch.

(d) Lifting chain is preferred, but corrosion-protected steel wire rope is acceptable.

(e) Chain boxes shall be provided for holding unloaded lengths of lifting chain.

(f) Wire rope hoists shall comply with the following:

- Drum diameter shall be at least 25 times the wire rope diameter.
- Drums shall have no more than three layers of wire rope when fully wound up.
- Drums shall have no fewer than three full turns of wire rope remaining when the hook is at the lowest design level.

D37.3.8. Hoist Trolleys

In addition to the general requirements for lifting equipment, hoist trolleys shall comply with the following:

Hoist trolleys shall be designed so that the trolley will remain on the support beam if a wheel falls off or a wheel axle fails.

D37.3.9. Crawl Beams

In addition to the general requirements for lifting equipment, crawl beams shall comply with the following:

(a) Crawl beams shall be fabricated from standard I-Sections or standard H-Sections.

(b) Crawl beams shall be hot-dip galvanised after all fabrication is complete. If the zinc coating is removed or damaged by drilling or welding or any other activity, the complete beam shall have the zinc removed by abrasive blasting and it shall be returned to the galvanisers for hot-dip galvanising.

(c) Crawl beams anchored to concrete shall be secured using grade 316 SS, or better, anchor bolts. The anchor bolts shall, preferably, be through-bolted. If through bolting is not feasible and chemical anchor is used, every anchor shall be tested to the design load for the anchor prior to installation of the beam.

(d) Mechanical expanding anchors are not acceptable for anchoring crawl beams.

(e) Crawl beams fastened to steel support structures shall be secured using hot-dip

[redacted]

galvanised fasteners.

D37.4. Davits

In addition to the general requirements for lifting equipment including SANS 1599, davits shall comply with the following:

(a) Davits shall be column mounted with swivelling booms and shall be designed to suit the application. Where specified in the Detailed Mechanical Specification, each davit shall be provided with a winch rigidly fixed to the davit at a convenient height and position.

(b) The davit shall be designed for a SWL at least 50 % above the load requirements of the equipment installation.

(c) Guide pulleys shall be provided to suit the arrangement. These pulleys shall be machined with a groove having a radius 5 % to 7,5 % greater than the rope radius and with a flare angle of 52°. The pulley effective diameter shall be not less than 25 times the wire rope diameter. The groove depth shall be twice the rope diameter or greater.

(d) The davit shall either be manufactured of grade 316L SS, or better, or of carbon steel, hot-dip galvanized and painted. All fasteners, pins, shafts, shackles, hooks, etc., shall be of 316 SS, or better. Guide pulleys and shafts shall be made of 316 SS, or better, or other approved corrosion resistant material, and shall use suitable non-metallic bearings which do not require lubrication.

(e) The swivelling arrangement shall be properly designed for easy operation, shall be accurately fitted and shall not be subject to corrosion problems. Bushes made of nylon, "Vesconite" or other suitable non-metallic material shall be used and any metallic rubbing mating face shall be of 316 stainless steel.

(f) Operating cross bars, locking arrangements, fixing arrangements, etc., shall not represent a hazard to passers-by. If necessary, operating levers shall be hinged so that they can be swung out of the way when not in use.

D37.5. Hand Cranked Winches

In addition to the general requirements for lifting equipment, hand cranked winches shall comply with the following:

(a) Hand cranked winches shall be rated for a SWL of at least 50 % in excess of the expected working load. All gears, clutches, etc., shall be enclosed in a robust cast iron, cast steel or fabricated stainless steel casing which shall be grease filled and sealed against ingress of dirt and moisture. The winch shall be designed to hold the load stationary when the hand crank is released during raising and lowering. In addition, a locking arrangement to lock the position of the load at any point shall be provided.

(b) The force required to operate the winch at its maximum rated load shall not exceed 130 Newtons.

(c) The wire rope shall be of stainless steel. The wire rope shall be long enough to reach the lowest required position and still have at least 3 turns remaining on the drum. The drum size shall easily store the full rope length. The drum shall have a diameter of at least 25 times the diameter of the wire rope.

(d) The support brackets, all exposed fasteners, shafts, handles, pins, etc., shall be of 316 SS, or better, and the casing shall be hot-dip galvanized or hot-metal zinc-sprayed (to a thickness of 150 µm) and then painted.

D38. BELT PRESS (including LINEAR SCREEN)

The General Specification covers equipment for sludge dewatering by linear screens and belt presses.

The requirements set out herewith are the minimum anticipated and the Contractor shall be responsible to ensure that the equipment proposed is suitable in all respects for the duties specified herein and in the Specific Requirements following.

D38.1. Type of Equipment

[redacted]

The equipment shall comprise of the following basic components:

a) Sludge pumping equipment.

b) Linear screen/s. (gravity sludge dewatering moving belt machine/s)

c) Filter belt presses.

d) Effluent wash water pumps.

e) Support and access structural steelwork.

f) Associated pipe work, valves, strainers and polymer injection device/s etc.

g) Ancillary equipment, (air compressor equipment or hydraulic equipment).

h) Sludge pumping equipment for dewatered sludge.

i) Electrical switch gear, cabling and instrumentation (if specified).

Coagulation chemical (polyelectrolyte) preparation and dosing equipment will be the subject of another specification and is not covered in this specification.

However the control of the dosing will be closely interfaced with the above equipment and the necessary instrumentation will be required to also measure, record and control the dosing equipment.

D38.2. General Design Parameters

The following requirements shall be met:

(a) The equipment shall be designed to facilitate efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.

(b) Belt life of more than 5000 hours should be achieved

(c) The equipment shall be designed to prevent undue stresses being produced by expansion and contraction due to temperature change, and other local natural and manmade conditions.

(d) The equipment shall be designed to keep maintenance cost to a minimum.

(e) The equipment shall comply with the legal requirements in respect of safety and the prevention of environmental pollution.

(f) The equipment shall satisfy any specific requirement contained in the relevant statutory codes and legislation.

(g) All equipment shall be provided to provide a fully operational plant within the scope of the contract.

(h) All materials from which the equipment is manufactured shall be compatible with the chemicals used and suitable for the intended duty and service conditions.

(i) All equipment shall be suitably treated and protected from corrosion and erosion.

(j) After approval by the engineer, at the time of the award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.

(k) All electrical equipment, forming part of the specified equipment, shall be sealed against penetration by the spray belt cleaning water in use, which may be in aerosol form, and be also accessible for repair and maintenance.

D38.3. Sludge to be Dewatered

The source and type of sludge/s to be dewatered, together with its / their dry solids concentration, shall be as indicated in the Specific requirements following.

D38.4. Process Description and Design

The following basic steps shall be followed for the dewatering of sludge using linear belt type dewatering screens.

1) Treat the sludge with a chemical to coagulate the sludge particles.

2) Handle the coagulated sludge gently to avoid breakup of the coagulated particles.

[redacted]

3) Dewater the sludge on a moving mesh belt under gravity.

Special attention shall be given to the mesh belts, the speed of the belts and the positioning of ploughs in the gravity dewatering zone.

The equipment shall be capable of dewatering the sludge/s specified in the scope of Works, and shall be designed and selected by the Contractor to achieve the dewatered sludge dry solids concentration, solids recovery and polyelectrolyte consumption as specified in the Scope of Work.

The dewatering installation is depicted on the process and instrumentation diagram and the Site layout Drawings provided. The installation comprises the following major units:

a) Sludge feed pumps.

b) Polyelectrolyte dosing equipment.(not part on this specification)

c) Linear dewatering screen machine/s.

d) Dewatered sludge pumps.

e) Service water tank and pumps for the supply of wash water.

f) Air compressing equipment (if applicable).

D38.5. Equipment Required

The equipment to be provided shall comprise the following, unless otherwise indicated in the Specific Requirements:

a) Sludge feed pumping equipment.

b) Linear dewatering screen machine/s.

c) Access platform steelwork.

d) Service water pumps and automatic backwash inline strainer.

e) Dewatered sludge pumps.

f) Associated piping, valves and fittings.

g) Air compressing equipment (or alternatively).

h) Hydraulic power pack equipment.

i) Electrical switchgear, cabling and instrumentation.

j) Laboratory equipment.

k) Ultrasonic level measuring and control equipment for the sludge storage tank/s.

l) Magnetic flow meter to measure the rate of flow of wash water to each dewatering unit.

m) Magnetic flow meter/s to measure the rate of flow of wash water and filtrate discharged from the dewatering equipment.

n) Solids density meter to measure the concentration of feed sludge to the dewatering equipment.

o) Solids density meter to measure the concentration of dewatered sludge from the dewatering equipment.

p) Solids density meter/s to measure the concentration of dewatered sludge from the dewatering equipment.

D39. CENTRIFUGES

D39.1. General

The centrifuge shall be of the horizontal solid bowl type with fully variable differential speed control of the scroll. The centrifuge shall be of a type with proven performance on the specified duty.

Operational problems must be minimised. All openings, particularly in the sludge feed and cake discharge areas shall be of adequate size and design to prevent plugging or bridging. Sludge feed velocity into the centrifuge shall not exceed 2,5 m/s at design capacity.

[redacted]

The point of polymer addition shall be recommended by the Tenderer to suit the recommended type of polyelectrolyte but the option of polymer addition into the bowl of the centrifuge must be provided.

Provision shall be made for automatically flushing the centrifuge after operation. A manually operated flushing valve shall also be provided.

D39.2. Casing

Casings shall be split and flanged down the centreline with adequate access covers for inspection of the dewatered solids discharge area and for easy access to the centrate discharge weirs for pool level adjustment. Sealing arrangements of all mating seal faces shall prevent any leakage. The casing shall be of rigid construction with baffles to ensure separation of the cake and centrate. Lifting lugs for the upper casing and handles for access covers shall be provided.

The casing, including all covers and fasteners, shall be manufactured of either grade 304 SS painted or of grade 316 SS, or better. The internal surface areas at the centrate and sludge discharge points must be suitably protected against abrasion using a lining material or approved thick coating.

D39.3. Bowl

The bowl assembly shall be of grade 316 SS, or better, construction with replaceable corrosion and abrasion resistant liners in the cylindrical and dewatering beach section and sintered tungsten carbide replaceable liners at the cake discharge ports.

Provision shall be made for measurement of the scroll flight wear via sealed ports provided in the bowl.

All fasteners shall be of grade 316 SS, or better, and so positioned as to avoid wear and shall be protected against plugging of clearances and holes for spanners and keys.

D39.4. Scroll

Scrolls shall be of grade 316 SS, or better, and protected against wear on the outer edges. This protection shall take the form of metal-backed, tungsten carbide components which are welded to the scroll and which can be replaced without causing structural damage to the scroll.

The feed sludge entry ports shall be fitted with replaceable abrasion resistant liners. The sludge feed pipe shall be easily replaceable and fabricated from an abrasion and corrosion resistant material or shall be suitably lined.

D39.5. Bearings

The main centrifuge bearings and scroll bearings shall be grease lubricated and shall be adequately sealed to prevent moisture or solids entering the bearings and to prevent lubricant entering the bowl. Details of the sealing arrangements shall be provided in the design. Grease nipples which are easily accessible from outside the centrifuge shall be provided for all bearings.

Designs incorporating bearings which must be oil lubricated shall include for a system which will protect the bearings during the centrifuge run down period in the event of a power failure. Oil lubrication systems shall include all necessary ancillaries including oil pump, suction filter, discharge filter with blockage indicator, pressure relief valve, an adequate reservoir with drain, plugged drain valve, filler and breather cap, level indicator and temperature gauge, oil cooler with connecting pipework, protection switches.

D39.6. Materials of Construction

The materials of construction shall be as follows:

(a) Structural steelwork shall be protected by a duplex system (HDG plus organic coating); or shall be hot-metal zinc-sprayed and sealed.

(b) Ducting shall be of grade 316 SS, or better.

(c) Hoppers shall be of grade 316 SS, or better.

(d) Small items such as brackets, etc., shall be hot-dip galvanized and coated or shall be of grade 316 SS, or better.

(e) Sludge pipework shall be of 316 SS, or better, HDPE or shall be of cast iron protected internally and externally with System for Large Immersed Steel Fabrications (not requiring decorative finish); i.e. polyamine/amide cured coal tar epoxy.

[redacted]

(f) Centrate pipework shall be of HDPE.

(g) Polyelectrolyte pipework shall be of grade 316 SS, or better.

(h) Water pipework up to 25 mm diameter shall be of copper. Water pipework above 25 mm shall be HDPE, PP or of carbon steel and protected with System "Fusion Bonded Epoxy".

D39.7. Centrifuge Drive Arrangement

The centrifuge shall be V-belt driven by an electric motor through a fluid coupling or by a frequency controlled variable speed motor, as recommended by the centrifuge manufacturer.

The motor and drive arrangement shall be adequately rated for the maximum load which can apply at any operating condition. In particular, the torque characteristics of a motor, fluid coupling and load under starting conditions shall ensure that the motor reaches full speed within 10 seconds and that the centrifuge reaches full speed with a substantial margin before causing overheating of the fluid coupling. Similar requirements apply to variable speed drives and their motors.

Contractors shall provide full details of torque characteristics and starting times for approval before commencing with manufacture.

The motor shall be mounted on slide rails incorporating stainless steel jacking screws.

Fluid couplings shall be suitably protected. This shall include protection from high temperature due to operation at high slip for extended periods.

D39.8. Centrifuge Mounting Arrangement

Each centrifuge and motor unit shall be mounted on a common fabricated steel baseplate. A high mass, very rigid base arrangement is required with low deflection of the vibration isolation mounting system during operation.

Foundations will be constructed, usually by others under a separate building contract, in accordance with the details and requirements which shall be provided by the Contractor.

Vibration isolation mountings which will eliminate not less than 90 % of the vibrations transmitted by the equipment shall be provided between the centrifuge baseplate and the concrete foundations. Full details shall be provided with the tender. When mounted on the vibration isolators, distortion of the baseplate shall be negligible in comparison with the permissible and acceptable misalignment of the equipment mounted thereon.

All cable, pipework and other connections to the machine shall be flexible and so fixed and mounted as to prevent wear and fatigue.

D39.9. Centrifuge Scroll Differential Speed Control

Variable speed scroll drive systems utilising electronic frequency variation, preferably, or air cooled electric braking systems may be used. Hydraulic drives will only be acceptable if electric/electronic systems are unavailable. If used, hydraulic power packs shall be properly designed and shall include all necessary ancillaries including oil pump, suction filter, discharge filter with blockage indicator, pressure relief valves, an adequate reservoir with drain, plugged drain valve, filler and breather cap, level indicator and temperature gauge, an oil cooler where necessary with connecting pipework, protection switches. All systems shall be so designed that no damage may result during the centrifuge run down period in the event of a power failure. Noise levels must also be kept low.

The scroll differential speed control shall be designed to provide a selectable option of either maintaining a selected differential speed or of maintaining a constant drive torque.

Provision must be made at the position of adjustment for indication of both differential speed and scroll torque.

The gearbox and differential speed control system shall be adequately rated for the duty using a service factor of at least 1,75. Gearboxes shall be oil lubricated and sealed.

Further requirements with regard to control and instrumentation are specified elsewhere in this Specification.

D39.10. Centrifuge Discharge Diverter

A means of diverting flushing water and thin sludge from the cake discharge opening shall be

[redacted]

provided.

D39.11. Sludge and Centrate Discharge Ducting

Ducting and pipework shall be provided to guide the thickened or dewatered sludge and centrate without hangup, bridging, leakage, overflow or blockage. Consideration must be given in the design to the stickiness of sludge and all duct surfaces must be vertical or very steep.

The arrangement shall be such that no spillage or other mess occurs during start-up, normal operation or shut-down. All sections of the discharge ducting shall be individually flanged for separate removal.

D39.12. Sampling

Suitable sampling connections shall be provided for sludge, cake and centrate. These connections must be conveniently located and not less than DN 50.

D39.13. Centrifuge Maintenance

The anticipated short and long term maintenance schedules for the centrifuge should be available. This schedule shall list the estimated maintenance which will be required at various stated intervals including lists of parts which will need to be reconditioned or replaced at each service and the present cost of the reconditioning and parts.

D40. MECHANICAL SCREENS

D40.1. Performance requirements

The screen shall be capable of operating correctly during the full range of flows in the channel, including the specified peak flow rate.

The screen shall withstand the force of water against a blocked screen field without damage when the channel is full upstream and empty downstream and the raking shall operate successfully under this condition.

The rake comb shall engage the screen field freely and shall travel smoothly up to the discharge point. Objects with an effective diameter of less than 250 mm shall be successfully removed without falling back into the channel.

The rake mechanism shall clear the full screen field and shall prevent accumulation of solids at the foot of the screen.

Solid matter shall not accumulate within the screen body or the discharge chute. It shall not be necessary for the operator to clear the unit.

Operation shall be jerk free.

The screen shall be designed to operate reliably when screening a wide range of types of solids as the exact composition of solids cannot be reliably predicted. The total solids loading of wastewater is random and variable but is normally taken as being about 0.3 kg/m3. In wastewater applications, a screen shall be capable of handling this loading at maximum flow and shall be capable of dealing with rags, hard solids, stringy solids, plastic and other solids which can be expected from a mixture of domestic and industrial wastewater.

D40.2. Type and configuration

The screen shall be installed in a channel and shall be designed for motorised removal of solids from the flow in the channel. The screen field shall be cleared of screenings by a chain actuated rake which engages with the front of the screen field, collects the screenings in its upward movement and then deposits the screenings via a discharge chute.

D40.3. Material

The frame, rake mechanism, screen field, chains, sprockets, doors, covers, chutes and any fasteners used shall be manufactured from EN Grade 1.4401 (316) stainless steel.

All stainless steel to be pickled and passivated if not in contact with less noble material. If exposed to anaerobic conditions seal-coat all crevices with Elastoplastic Epoxy. Passivation shall be done by the dipping process.

Combs and wiper blades shall be manufactured from a suitable polymeric or elastomeric material.

D40.4. Screen element

[redacted]

The screen field shall span the width of the channel and shall extend to at least 200 mm above the maximum water surface level.

The bars forming the screen field shall be robust and accurately aligned. Screen fields with a bar spacing of 6 mm or greater shall have a screen bar thickness of not less than 8 mm and a screen bar depth of not less than 40 mm.

Flow velocity through the nominal (total) area of the screen field shall not exceed 0.9 m/s at the maximum specified flow.

The screen field shall be removable and replaceable without removing or dismantling the frame.

D40.5. Frame

The screen frame shall be robust, rigid and durable. It shall be self-supporting and the screen unit shall be designed to be hoisted when in fully assembled condition.

Screens which have side frames longer than five metres shall be provided with additional anchor supports in order to prevent flexing of the structure. Screens which protrude more than two metres above floor level shall be provided with additional support struts.

The cradle brackets which anchor the screen's frame at the top of the channel shall be of stainless steel with a wall thickness of not less than 4.5 mm. Each bracket shall be provided with at least 4 anchor fasteners per bracket. These four anchors shall not be in linear formation and shall preferably be in rectangular formation.

D40.6. Grit

The flow being screened will contain grit. The design shall ensure reliability and shall provide adequate resistance to wear. Sliding contact between similar metals is not acceptable except for the replaceable items such as the screen field and rake comb.

D40.7. Rake comb and wiper

The rake comb shall be replaceable.

The rake comb wiper shall have a non-metallic blade which shall wipe the screenings from the rake into the discharge chute. The wiper shall be activated when the rake reaches the top position. The wiper shall not be activated by metal on metal sliding contact. If the comb teeth are used to activate the wiper, the effective linear contact surface shall total at least 75 mm.

The wiper blade shall be replaceable.

D40.8. Discharge chute

The discharge chute shall be designed to prevent screenings from building up.

D40.9. Enclosure

The screen shall be enclosed above the top level of the channel for safety reasons.

Doors for inspection, cleaning and maintenance of the working parts shall be provided in front. A removable door shall also be provided at the rear in a position to allow inspection of the wiper mechanism.

The front doors at the operator's working level shall be provided with stainless steel hinges and shall open safely. Designs which place stress on the hinge when open are not acceptable. The doors shall be stable when both fully open and fully closed. The height dimension of each door shall not be greater than 800 mm in order to make them easy to open and close.

A duct with an area of at least 0.03 m2 shall be provided at a high point for drawing off foul air.

Screen frames which are mounted against the flat surfaces of channel walls and floor shall be provided with cradle brackets which securely position the screen.

No flow shall pass between the frame and the concrete.

D40.10. Operation and control

It shall be possible to start the operation of the rake mechanism of a screen by pushbutton. Protection systems shall function during manual starting and stopping.

It shall be possible to operate all of the screens simultaneously.

Any process parameter which is monitored electronically shall be indicated on the SCADA and/or



the HMI mimics (if these are applicable).

The screen field shall be raked by the rake mechanism when the difference between the upstream level and the downstream level reaches a set-point which indicates that the screen field has reached a certain degree of blockage. For this purpose, the level both upstream and downstream of the screen shall be measured by ultrasonic units. The differential level set-point shall be adjustable (with password protection).

Time based initiation of the cycle shall also be provided. The timer shall be initially set at 15 minutes. The set-point shall be adjustable (with password protection) between 5 minutes and 180 minutes.

The unit's control system shall prevent damage to the screen field and the rake mechanism from obstructions by sensing an overload, stopping the rake movement and activating an appropriate alarm.

Operation of the screen shall be coordinated with the operation of downstream equipment and any other associated equipment necessary to convey the screenings to the final discharge point without blockage.

D41. AUTOMATIC POLYELECTROLYTE DOSING SYSTEM

The system shall be of proprietary, unit design which has been tested in practice.

The system shall be chosen for the application and shall have volume flow capacity and polyelectrolyte dosing capacity of at least 20 % above the design ranges for the application.

The polyelectrolyte make-up and stock tanks shall be of GRP or stainless steel.

The polyelectrolyte stock tank shall be sized to provide at least six hours of polyelectrolyte dosing before refilling.

Polyelectrolyte dosing pumps shall be selected to avoid high shear on the liquid being pumped. Preferred types of pumps include progressing cavity and peristaltic pumps.

D42. ELECTRICAL GENERATOR - ENGINE DRIVEN

D42.1. Equipment

This Clause deals mainly with the overall requirements and the mechanical aspects of the equipment. The detail electrical requirements are specified in the Electrical Specification.

Engine-driven electricity generating set (genset) installations shall include an engine-driven alternator, shaft coupling, engine and alternator cooling system, starting system, double baseplate and anti-vibration mounting system, exhaust system, fuel tank, electrical control panel and specified spares.

Engines shall be diesel powered and ISO 9001 approved, unless otherwise stated in the Detailed Mechanical Specification.

D42.2. Arrangement

The engine and generator shall be rigidly mounted on a steel baseframe. This baseframe shall be supported on anti-vibration mounts within a second steel baseframe.

The alternator shaft shall be supported separately from the engine shaft on a minimum of two bearings and the engine/alternator shaft coupling shall be of the flexible type.

Both baseframes shall be hot-dip galvanised after fabrication.

The outer baseframe of units to be installed on floors shall incorporate skids and shall be provided with four jacking points. After the genset is positioned correctly, suitably designed vibration pads (Tico, or equivalent) shall be placed between the skids and the concrete floor.

D42.3. Performance

The complete genset installation shall be capable of the kW and kVA output and any other performance requirement specified in the Detailed Mechanical Specification for continuous as well as for high current (motor starting) requirements. The genset rating shall provide for these performance requirements whilst maintaining the frequency and voltage within the ranges specified in the Electrical Specification.

D42.4. Engine



Unless otherwise specified in the Detailed Mechanical Specification, the engine shall be a multi-cylinder, diesel-fuelled compression ignition unit. It shall run at 1 500 rpm which shall not be greater than 85 % of its rated full speed. The power rating shall be in accordance with an approved British Standard or other approved by the Engineer. Tenderers shall provide full details with their tender documents.

The net power output rating of the engine at 1 500 rpm with all driven accessories as installed and for continuous operation shall be **at least** 15 % greater than the full generator input power (kilowatt) required.

D42.5. Engine Environment

The engine cooling and ventilation system shall cater for all air needs such as combustion air, ventilation air and the cooling air requirements for the engine cooling system. Air for combustion, engine cooling and ambient cooling shall be drawn from an area free of the heated discharge(s) and the exhaust emission.

If the engine is of the water-cooled type, the engine coolant shall be treated with the engine manufacturer's recommended anti-corrosive, water soluble coolant.

If the genset is to be installed in an enclosure or closed room, the allowable temperature rise to be used for the design of plant room ventilation shall be 5 °C. Adequate ventilation shall be provided to remove from the enclosure the radiation and convection heat losses from the generating set (to be taken as a minimum of 33 % of the maximum engine shaft power plus the heat resulting from the inefficiency of the generator).

Filtration shall be provided on the inlet and outlet duct to prevent the ingress of wind-blown dirt.

D42.6. Engine Lubrication

Engine oil filters shall be mounted in an accessible position.

An extension pipe with square headed plug shall be provided to facilitate draining oil from the sump.

Certain control functions are specified for the monitoring and control of engine lubrication.

D42.7. Combustion Air Intake

A two-stage cyclonic dry type air cleaner shall be fitted and shall have water and dust evacuators. The air cleaner shall be amply rated for the application. There shall be no flow restrictions and the complete air induction system shall have the approval of the engine manufacturer.

The air filter shall be designed to reduce intake noise breakout.

D42.8. Exhaust and Silencing System

All piping for the exhaust system shall be of grade 409 stainless steel. The silencers and all pipe support brackets shall also be of stainless steel.

Where required to satisfy the OHS Act requirements, the exhaust system, including silencers, shall be acoustically insulated with a preformed mineral wool inner layer sealed with asbestos free finishing plaster.

Exhaust outlets shall be protected against the ingress of rain.

The silencing system for engines above 25 kW shall include a reactive silencer and an absorptive type silencer and all support brackets. A flexible connection of the bellows type shall be installed as close to the manifold(s) as possible to limit vibration transfer and to allow expansion under heating. The standard reactive (i.e. pulsation damper type) silencer shall be installed downstream of the flexible connection. The distance between the engine and the reactive silencer shall be designed to avoid resonance. An additional absorptive silencer, Burgess or equivalent, shall be installed downstream of the reactive silencer. The tail pipe shall have a length of at least 15 times the pipe diameter, measured downstream of the absorptive silencer.

Where the genset is installed inside an enclosure or room, both silencers shall be installed inside the enclosure. The exhaust outlet shall be led outside the genset enclosure to discharge at least three meters above ground level.

D42.9. Engine Fuel System

A primary and a secondary fuel filter of the replacement element type shall be provided. In addition, a water trap ("Otomatik" type, or equivalent) shall be provided. All three shall be installed

between the fuel tank and the injector pump.

Piping between the fuel tank and the engine shall be of stainless steel and a flexible section for absorbing vibration shall be fitted, at the engine, to meet the requirements and approval of the engine manufacturer.

The flow velocity in the suction piping shall not exceed 0,8 metres per second (based on 3 times the fuel consumption at the rated load). The tank suction connection shall be at least 50 mm above the tank bottom.

A fuel return line from the engine shall be connected to the tank at the same level as the suction line and its diameter shall be the same as that of the suction line.

A fusible-link controlled, shut-off valve shall be mounted in the fuel supply line above the engine and this shall close in the event of fire. A manual shut-off valve shall be installed upstream of this valve.

D42.10. Starting

Refer to the Detailed Mechanical Specification for the required starting details.

D42.11. Acoustically Enclosed Applications

Gensets which, in order to control noise, are installed in rooms shall have their air supply and discharge openings fitted with acoustic attenuators adequately designed to ensure a noise level at 1 metre from the openings outside the plant room of no more than 60 dBa impulse rating level. The attenuators shall incorporate sound absorbent elements (Donkin, Trox or equivalent).

Each opening shall be provided with a weather louvre and an internal mesh screen.

Silenced units shall be as specified in the Detailed Mechanical Specification.

D42.12. Operation and Control

The required method of starting and stopping is described in the Detailed Mechanical Specification.

All monitored items shall be displayed. Monitored and displayed items shall include the following:

(a) generator output power (kW).
(b) generator apparent power (kVA).
(c) generator power factor.
(d) generator voltage.
(e) generator current.
(f) generator speed.
(g) engine coolant inlet temperature.
(h) engine coolant outlet temperature.
(i) engine oil pressure.
(j) fuel tank level.

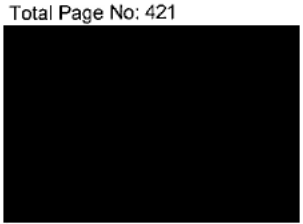
The following alarms shall cause a system trip:

(a) high engine coolant temperature (if applicable).
(b) engine coolant low flow (if applicable).
(c) low engine oil pressure.
(d) high ambient temperature in enclosure (if applicable).

D42.13. Acceptance Tests

The tests which shall be carried out by the Contractor to certify that the equipment is operating in accordance with the performance requirements in this Specification shall include the following:

(a) fuel lines shall be tested for airtightness prior to filling.
(b) a test shall be done to verify the guaranteed power output. The Contractor shall do preliminary tests and make adjustments as necessary. Once all adjustments have been carried out, the generating set shall operate for a period of not less than 15 minutes to



permit conditions to settle down before proceeding with the acceptance test. The acceptance test shall be run for not less than 30 minutes at full specified continuous power output with electrical power output readings being taken every 5 minutes. The arithmetic average of these results will be taken as the official test result. All monitored parameters shall also be recorded.

(c) test that the genset is able to start the largest motor as specified.

(d) tests to show that each protection circuit is operational.

(e) pressure tests of all pipework.

(f) operation of all components of the system individually and as a system.

(g) where the genset is installed in an enclosure or room, the allowable temperature rise for plant room ambient is 5 °C and this shall be confirmed during continuous operation for a period of at least two hours.

The Contractor shall make all arrangements and shall provide all equipment required to perform the above tests, including the provision of load resistor banks or equivalent.

D42.14. Spares

The following spares shall be provided if stated as a requirement in the Detailed Mechanical Specification:

(a) complete set of diesel injectors (1 off per genset).

(b) complete diesel injector pump (1 off per genset).

(c) complete engine gasket set (1 off per genset).

(d) complete engine fanbelt set (1 off per genset).

(e) complete air filter set (2 off per genset).

(f) complete fuel filter set (2 off per genset).

(g) complete oil filter set (2 off per genset).

Technical information to be provided for the operating staff shall be comprehensive and tailored to be specifically applicable to the installation.

Two fire extinguishers of a suitable size and type shall be provided and shall be mounted suitably for the application.

D43. DIESEL FUEL TANKS

Requirements For All Tanks

The detailed design requirements, including capacity, are specified in the Detailed Mechanical Specification.

The complete tank, pumping system and piping arrangement shall comply with all applicable fire prevention regulations.

All fixed electrical equipment and wiring shall be installed in accordance with the recommendations of SANS 10108.

The tank shall be provided with an equalisation vent. A drain at the lowest point shall be provided and shall have a lockable isolating valve (with the exception of underground tanks). All pipe connections to the tank shall be provided with isolating valves.

Diesel tanks serving diesel engines shall be mounted on a stand at the correct level to provide the engine manufacturer's required gravity feed to the engine's injection pump. The bottom of the tank shall not be more than 500 mm below the level of the diesel injectors.

D43.1. Requirements for Tanks Installed Above Ground

Apart from where they conflict with the specific details of this Specification, the complete design and installation shall be in accordance with SANS 10131.

In addition to any other measuring device, the tank shall be fitted with an indicating fuel level gauge of the rotating dial float level type for visual checking.

The filling arrangement shall be designed for use with conventional road tankers.

[redacted]

D43.2. Requirements for Underground Tanks

Tanks which are installed underground shall be in accordance with SANS 1535.

Provision shall be made for withdrawing sludge from the lowest part of the tank. Fuel in the tank shall be drawn from a position distant from this lowest point.

The filling arrangement shall be designed for use with conventional road tankers.

D43.3. Requirements For Tanks For Mobile Applications

Tanks for units which are transportable shall comply with the requirements of SANS 1518.

D44. INSTRUMENTATION

Environmental protection of electronic instrumentation shall be as follows:

(a) Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.

(b) Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self draining.

(c) Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all-round the instrument.

Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.

Calibration certificates shall be included in the Manual.

D44.1. FLOW METERS

D44.1.1. Electromagnetic Flow Meters

Electromagnetic flow meter sensors shall be full-bore, in-line, double-flanged units with remotely mounted transmitters. The transmitters shall provide local flow indication and 4-20 mA output. Sensors shall, unless otherwise specified, have IP 68 protection and transmitters shall have IP 67 protection.

Electromagnetic flow meters shall have polyurethane lined stainless steel tubes with either Titanium or Hastelloy C electrodes. Accuracy shall be ± 1 % of flow or better. Rubber linings are acceptable for treated water applications.

Calibration shall be in litres per second unless otherwise specified.

For applications other than for treated water, flow meters shall be provided with an electronically operated electrode cleaning device. Automatic, timed cleaning shall be provided.

Installation

The equipment shall be correctly installed, connected, adjusted and calibrated by competent persons. Calibration shall be done in the presence of the Engineer. The operation and signal transmission of meters against electromagnetic interference shall be provided.

The meter shall be installed with a straight pipe length of at least 10 pipe diameters upstream of the sensor and a straight pipe length of at least 5 pipe diameters downstream of the meter. If this is not possible, specific measures shall be taken to provide flow straightening. The complete meter installation shall comply with the manufacturer's instructions.

Grounding rings shall be supplied and installed if the application requires these.

Testing

A factory test calibration certificate shall be provided for each flow meter.

The flow meter shall be provided with a simulation test unit for field verification of the measuring system without removal of the sensor. If more than one identical model flow meter is installed, two simulation test units shall be provided.



D44.1.2. Visual Flow Meters and Indicators

General

Visual flow meters or flow indicators shall be provided if specified in the Detailed Mechanical Specification. These are normally used for auxiliary circuits such as cooling and lubrication circuits and for flushing of mechanical seals.

Design and Materials

The units shall be of the double window type with a graduated indicating flap. Flow indicators which utilize a moving spinner or ball will be acceptable in some applications.

The body shall be double flanged and shall incorporate easy dismantling to allow cleaning of the windows.

Bodies shall be of stainless steel.

D44.2. GAUGES

D44.2.1. Gauges – General

Gauges shall comply with the following:

(a) Gauges shall be of durable, industrial construction. Case and bezel shall be of stainless steel unless this material is unsuitable.

(b) Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1 % - 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating.

(c) On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of the gauge.

(d) The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

(e) Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values. Such markings shall always be on the inner scale face and not on the glass face.

(f) The units of measurement shall be clearly marked on the dial. A printed label of approved non-corrosive material indicating the duty of the gauge shall be neatly fixed on or near the gauge.

D44.2.2. Gauge Installation and Mounting

Gauges shall be installed and mounted in accordance with the following:

(a) Gauges shall be mounted vertically and in such a position that they can be easily read from floor level.

(b) Flanged nozzles for gauge tappings shall be provided on the parent pipework. Nozzles shall comply with the requirements of the Clause "Pipework".

(c) Gauges for permanent equipment installations, such as for centrifugal and reciprocating pumps, shall not be mounted directly on pipework but shall be mounted on a wall or on a pedestal stand so as to minimise vibration. Gauge cocks shall be provided at each end of the connecting pipework.

(d) Pressure gauges shall be fitted with an isolating and air bleed cock.

(e) Pressure gauges used on sewage, sludge, powder, chemical or other applications where blockage or corrosion of the gauge is possible shall be fitted with a diaphragm type chemical seal, both being liquid filled. The portion of the seal in contact with the process liquid shall be of a suitable non-corroding material and, when solids are handled, shall have a large threaded socket connection not smaller than 1" BSP.

(f) Gauges for liquids containing solids shall have the nozzle on the side of the parent pipe and the configuration shall allow easy cleaning of the passageways.

D44.2.3. Pressure Gauges

[redacted]

Terminology:

Absolute pressure is relative to a perfect vacuum.

Differential pressure is the difference between two input pressures.

Gauge pressure is the pressure measured above the local atmospheric pressure. It is the most common pressure measurement.

Vacuum pressure is lower than atmospheric pressure.

Pressure gauges shall comply with the following:

(a) Pressure, vacuum or compound gauges shall comply with SANS 1062. Gauges shall be of Accuracy class 1.6 and Durability grade A unless otherwise specified. The gauges shall bear the Standards South Africa mark.

(b) Gauges shall have a scale diameter of not less than 100 mm.

(c) Calibration shall be in kiloPascals with the full scale reading between 1,5 and 2 times maximum actual operating pressure except where otherwise specified. The full scale reading for a gauge on the discharge leg of a centrifugal pump shall be higher than the pump shut-off head.

(d) All gauges shall be suitable for continuous operation and shall be liquid filled on all pump applications and where fluctuations in pressure may cause damage.

(e) Gauges shall not be mounted directly on equipment subject to vibration. Gauges in pump stations shall not be mounted directly on the pipework and shall be connected to the pressure tapping point by small diameter stainless steel pipework.

(f) For dry locations indoors, the casing may be reinforced plastic or epoxy coated aluminium and the elastic element and shank of stainless steel. For damp indoor locations, particularly in any location where sewage is flowing, and for all locations outdoors, the gauges shall be weatherproof and have the cases and other metal components of grade 316 stainless steel.

(g) Pressure gauges shall be fitted with an isolating and air bleed cock.

(h) When used on steam lines a siphon shall be fitted between the steam line and the gauge which shall be filled with water before putting the gauge into service

D44.2.4. Temperature Gauges

Temperature gauges shall comply with the following:

(a) Temperature gauges shall have dials not less than 120 mm diameter. Accuracy shall be ± 1 % of reading or better.

(b) The gauges shall be fitted vertically into removable 316 stainless steel wells and the gauges shall be removable without leakage from the pipe or vessel. Protrusion into a pipeline shall be kept to a minimum. When handling sludge, sewage or other abrasive liquids the protrusion shall not exceed 15 mm and in this case the wells shall also be of a heavy duty abrasion resistant type.

D44.2.5. THERMOMETERS

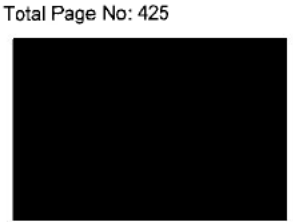
Thermometers shall be of the liquid column type and the complete tube shall be protected by a sturdy pocket of stainless steel or brass.

D45. VENTILATION SYSTEMS

D45.1. Design

Performance requirements to be achieved by the Contractor's design are specified in the Detailed Mechanical Specification.

Resistance to flow for all ductwork, pipework and associated equipment shall be calculated by the Contractor prior to equipment selection. At least 250 Pa shall be allowed for resistance losses in filters unless the Contractor can confirm a lower figure. Reasonable modification to ductwork and pipework during installation shall be provided for in the design; i.e. a suitable safety factor shall be incorporated in the design.



D45.2. Fans

Direct-drive, axial-flow fans shall incorporate manually adjustable pitch, cast aluminium, aerofoil section blades, clamped in split, metallic hubs. Terminal boxes shall be mounted on the fan unit. Fan casings shall cover the overall length of the fan and motor assembly or shall feature a plate mount which incorporates a bell mouth inlet. Suspended fans shall be restrained to prevent excessive torsional and axial movement during start-up.

Axial flow fans installed in corrosive flows shall be either belt-driven or shall have their motors protected by bifurcated airstreams.

Centrifugal fans shall be constructed of galvanized sheet steel with spun steel inlet cones and machined shafting supported on rolling bearings mounted in sealed bearing housings provided with grease nipples. The open type bearing units with exposed "lubricated for life" bearings will not be acceptable. Fans shall be mounted on steel channel base frames sized to accommodate drive motors.

Fan motors shall be protected to IP 55 or higher. Fans and motors shall preferably have a nominal speed of 1 500 rpm or lower and motors shall have a nominal voltage of 400 Volts.

Fans shall be dynamically balanced to ISO 1940, grade G6,3. Fans shall be flexibly connected to ducting.

Fan/motor housings shall, as a minimum, be provided with rubber mountings. Where flexible mounting is specified, fans shall be flexibly supported off the structure using spring or rubber-in-shear mountings having a minimum static deflection of 20 mm. Suction and discharge areas shall be effectively guarded with hot-dip galvanized (or better) wire screens of 12 mm maximum mesh and 1,6 mm minimum gauge. Belt drives shall be accurately aligned axially and angularly and shall be to the Engineer's approval. Guarding shall totally enclose drives, shall be rigidly mounted off base plates and shall be to the Engineer's approval.

D45.3. Ducting and Sheet Metal

All ducting for air conditioning and ventilation purposes shall be manufactured in accordance with SANS 1238.

Volume control dampers shall be installed where required or where called for in the Detailed Mechanical Specification and shall be of the opposed blade type.

Unless otherwise specified, materials used in the fabrication of air conditioning and ventilation ductwork shall be of hot-dip galvanized, low carbon steel and sheet steel material thicknesses shall be in accordance with SANS 1238.

Flexible connections between ducting and moving equipment shall be by means of approved coated fabric collars with sewn and cemented seams. Flexible collars shall have sufficient free movement to take up the deflection of the connected moving equipment and shall not be used as a means of accommodating misalignment. When installed, collars shall not restrict the free area of the ducting and particular care shall be taken to avoid mounting flexible collars at fan intakes and discharges.

Take off sockets shall be provided where grilles or louvres are mounted in distribution ducting. Sockets shall be long enough to ensure that no part of the grille or its associated control mechanism projects into the duct cross-section. All such duct-mounted grilles shall be provided with opposed-blade, volume control dampers or flap-type volume controls with straightening blades.

Rectangular ducting shall be supported on trapeze type hangers constructed from hot-dip galvanized, low carbon steel angle with Ø10 stainless steel hanger rods. Rod diameter shall be not less than 10 mm and support spacing shall be less than 2 000 mm.

Circular ducting shall be supported in hoops constructed from 40 mm X 5 mm hot-dip galvanized low carbon steel flat bar suspended from Ø10 mm stainless steel rod at 3 000 mm maximum centres.

Where ductwork penetrates concrete slabs or walls, flanges shall be provided on one side to stabilize the duct and weak grout or fire stopping shall be applied to the spaces between the ducting and the structure to effectively seal the clearance. Where ducting penetrates between areas having differing fire risk or mandatory fire separation, fire dampers to the latest amendment of SANS 193 shall be installed to the Engineer's approval.

[redacted]

D45.4. Ventilation Filters

Filter cells shall be mounted in proprietary frames and clip-fixed to achieve zero discernible by-pass. Slide frame mounted filters shall have wing nut fixed airtight cover plates.

Filter banks shall have a differential manometer connected across them. Manometers shall be correctly set up and levelled and shall be provided with red gauge oil of the correct specific gravity.

The filter frame shall be fabricated from hot-dip galvanised steel (minimum thickness of 0,5 mm) unless otherwise specified in the Detailed Mechanical Specification.

Flow speed through the filter opening shall be not greater than 2 m/s.

D45.5. Sound Attenuators

Circular attenuators shall be directly connected to axial flow fan flanges. Where diameters differ by more than 20 mm, hot-dip galvanized low carbon steel connecting cones shall be bolted between the fan and the attenuator to adapt the respective diameters. Attenuators containing an acoustic pod shall have leading and trailing fairings in moulded grp or spun hot-dip galvanized steel. Pods shall be securely and concentrically fitted in the casings to the Engineer's approval.

Splitter attenuators shall be fabricated of galvanized sheet steel with mating flanges. Splitters shall comprise acoustic lining material mounted on galvanized sheet steel and shall be securely supported within the attenuator casing. Leading and trailing ends of splitters shall have fairings in moulded grp or hot-dip galvanized steel sheet.

Attenuators shall be constructed to achieve the overall acoustic performance specified. Acoustic infill material shall be "Eurolon" by Donkin or equivalent. Where air passageway velocities exceed 20 m/s, the infill material shall be supported by pre-galvanised perforated sheet steel having a thickness of at least 0,8 mm.

Where attenuators are to be used in grease or oil-laden atmospheres or where called for in the Detailed Mechanical Specification, a polyester membrane shall be interposed between the infill material and the perforated sheet.

Attenuators shall not impose a resistance of more than 50 Pa at rated air-flow.

External surfaces of the attenuators shall be painted as for the general ductwork.

D46. CHLORINATION SYSTEMS

The design of plant installations for chlorination shall suit the application concerned but shall comply, as a minimum, with SANS 10298.

D47. NOISE CONTROL

D47.1. Noise Levels

The sound power of any equipment shall not exceed 89 dB(A) (referred to 10^{-12} Watts) unless specifically approved by the Engineer. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for in the Detailed Mechanical Specification.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers; so that appropriate steps can be taken at the design stage to counteract the effects of noise.

D47.2. Acoustic Treatment

Acoustic enclosures are not acceptable unless specifically called for. Acoustic treatment of high noise sources must, however, be included where applicable where this can be done without greatly interfering with operation or maintenance.

Components which can move, such as those associated with expansion bellows or mechanical couplings, shall be enclosed by an effective acoustic enclosure designed to prevent sound transmission but able to cope with movement without damage.

D47.3. Measurement

[redacted]

Noise levels will be verified by taking impulse weighted L_{eq} readings in dBA over ten minutes at the specified positions. Readings so achieved shall not exceed the specified level by more than 2 dBA.

Should the noise exceed the specified level or should the level be in dispute, the Contractor will be responsible for obtaining certified sound pressure levels across the full octave band mid-frequency range in order to establish the precise A-weighted level.

D47.4. Equipment in Acoustically Sensitive Areas

Inertia bases for centrifugal fans, chillers, refrigerant compressors, air cooled condensers, air compressors, pumpsets, motors and the like shall consist of reinforced concrete cast into sheet metal formers and shall be at least 150 mm deep.

Bases shall be reinforced with, at least, Ø13 mm reinforcing bars located at 150 mm centres each way.

The mass ratio between bases and equipment shall be at least 1:1 for fans and 1,5:1 for pumps. Concrete bases for pumpsets shall be large enough to support pipes and fittings between the pumps and flexible connections and shall also be generally large enough to accommodate the motors and driven equipment. Equipment shall be bolted onto concrete inertia bases.

Structural steel bases shall be provided for cooling towers and evaporative condensers.

Spring isolators shall be installed between concrete inertia bases and floor plinths and between cooling towers or evaporative condensers and floor plinths. Either free standing stable spring units or caged spring units with snubbers may be used. Spring isolators shall be installed with levelling bolts and shall incorporate 6 mm thick ribbed neoprene acoustic pads bonded to the base. Spring diameters shall be large enough to prevent excessive rocking of equipment during start-up as well as normal operation.

Isolators shall be chosen to give a static deflection corresponding to a ratio of 3:1 of the lowest disturbing frequency to the natural frequency of the mounting.

Bases and spring isolators shall be arranged to give a clearance of approximately 25 mm between the underside of the bases and floor plinths.

Floor plinths shall be provided for all equipment bases. Plinths shall be large enough to accommodate the concrete inertia bases and spring isolators. Floor plinths shall also be provided under items of equipment, such as cooling towers, air plena etc., which do not require concrete inertia bases. Plinths under air plena shall be at least 100 mm higher than finished floor level.

D48. THERMAL LAGGING

Thermal insulation shall only be carried out after successful pressure testing of the equipment.

The efficiency of the insulation system shall exceed 90% and the insulation cold face temperature shall not exceed 40°C.

Pipe insulation shall consist of pre-formed insulation material having a thermal conductivity of approximately 0,040 W/mK at 60 °C. The insulation material shall not have any corrosive effect on the pipework or equipment.

Fibreglass may not be used on stainless steel.

Inside buildings, or in other protected areas, pipe insulation shall be supplied with a canvas covering having a 50 mm lap at one end and along the longitudinal seam. The laps shall be sealed using a suitable lagging adhesive. On bends the insulation material shall be neatly mitred and covered with canvas. At all flanges the insulation shall be closed off. Flanges, couplings, tees and valves shall be insulated using a removable canvas blanket or jacket fastened in place with brass hooks and eyes.

All insulation shall be coated with a suitable sealer and then painted in accordance with the colour code. The manufacturer shall advice regarding the paint types and system to be used.

Outside buildings or in other exposed areas pipe insulation shall be fixed in position using three bands per section or a suitable adhesive and then clad with aluminium. All longitudinal and circumferential joints shall incorporate a 50 mm lap with each edge grooved. The longitudinal joints shall be positioned in the "twenty past" position with the lap and groove downwards. All ends next to couplings or flanges shall be closed off and sealed before fitting muff type insulation and cladding over the couplings and flanges. All bends, tees and other fittings shall also be



insulated and clad but valves need not be insulated. All joints shall be primed and sealed using a silicone or other appropriate sealer and the contractor shall generally ensure that the lagging is weatherproof with particular attention being paid to all joints and pipework support or anchor points.

With large exposed items such as vessels mounted outside, a suitable system shall be recommended.

D49. CONTROL SYSTEMS

D49.1. General

Control systems shall comply with the following:

(a) Control shall function as an integrated, coherent system.

(b) Protection systems shall be designed to prevent damage to equipment. Failing to start, tripping or stopping of any item of equipment shall prevent the start-up or shall initiate the appropriate shut-down procedure of related equipment in cases where damage could occur.

(c) Emergency stop stations shall be provided near to each motor driven unit.

(d) Digital indicators shall provide no fewer than three significant places (and, preferably, no more than three).

D49.2. Design

The design of the control system, including drawings, functional specification, control panel layout, circuit diagrams and protection systems, shall be submitted to the Engineer for acceptance.

D49.3. Control Panels

Where the details of motor starter panels have not been specified in the electrical specifications, every 400 V starter panel shall include the following standard equipment:

(a) Circuit breaker (complete with auxiliary contacts for control circuits).

(b) Contactor.

(c) Overload relay with manual reset

(d) Ammeter (CT based, if above 40A).

(e) Starter alive indicating light (Red).

(f) Motor running indicating light (Green).

(g) Running hour meter.

(h) Selector switch.

(i) Stop push button.

(j) Start push button.

D49.4. PLC/SCADA Systems

Control systems utilising PLC/SCADA systems shall incorporate the following:

(a) The PLC/SCADA system shall be configured for equipment to be PLC controlled such that the installation will be able to operate following a failure of the SCADA system.

(b) Mimic screens provided for SCADA systems shall include the following (unless inapplicable):

- Overview of scheme; including the process flow diagram and indicating all electronically monitored parameters which are not included in a sub-system.
- Overview of each plant grouping.
- Individual unit (Centrifuge, compressor, pumpset, etc.).
- Equipment sequence selection.
- Equipment start interlocks.
- For each motor larger than 55 kW, motor status and, where applicable, motor protection

[redacted]

relay diagnostic.

- Electrical reticulation schematic.
- Hardware diagnostic.
- Alarms.
- Set-points for alarm, trip and control loop functions (including password protected alteration facility).
- Record of equipment and process parameters at instant of equipment trip and station trip (see also below).
- Event log.
- Trending of monitored system parameters (see also below).
- Communication status of control system hardware.
- SCADA security system current settings, including personnel names.
- Ancillary equipment status; e.g. security, fire detection, UPS.
- Printing.

(c) Trend screens shall be as follows:

- Screens may include logical operational groupings.
- Points of inflection of measured parameters shall be recorded.
- Trend screens shall be provided for 3 hours, for 7 days and for 3 months (unless the nature of the parameter demands different scales).

(d) At least one colour printer (for graphs, mimics, etc.) and one line printer (for alarms) shall be provided in accordance with the detailed specifications.

(e) The control system shall provide an alarm on the SCADA screen if an instruction to an item of equipment to start or stop does not cause that item to start or stop.

Alarm conditions which lead to the control system executing an equipment trip shall be logged. Subsequent alarms which occur as a result of the tripping action shall be logged as subordinate alarms. The condition which caused the trip shall be described with respect to the:

- Item of equipment.
- Trip setpoint reached.
- Description of parameter; i.e. flow, temperature, etc.
- Time of event.

(f) A time delay following an alarm condition leading to a control system trip shall be incorporated in order to prevent tripping actions caused by electrical disturbances or similar occurrences. The time delay chosen shall match the functional needs and shall be decided in conjunction with the Engineer.

(g) Three significant places shall be used for representation of values on SCADA systems.

D49.5. Testing and Commissioning of Control Systems

Setpoints for equipment and process parameters which are required for the operation of control systems shall be obtained once the equipment is operational.

The Contractor shall submit a schedule of all control functions to be checked on Site during testing and commissioning. This shall be submitted for acceptance by the Engineer. The format shall be as follows, or similar:

COMMISSIONING - CONTROL SYSTEM TESTS				
Date	Test Function	Test Method	Result (e.g. SCADA message, etc.)	Proposed Corrective Action

[redacted]

D50. PACKAGING AND TRANSPORTATION

Equipment must be wrapped (bubble) or covered with appropriate means to prevent cross contamination or damage as a result of handling, storage or transportation.

Equipment shall be clearly identified on the outside of any protective packaging. If required, only elastomeric or fabric webbing straps shall be used for lifting purposes during loading, unloading and installation.

D51. CIVIL WORKS: CONTRACTOR'S RESPONSIBILITY

Civils works including buildings and concrete structures will include all plinths, foundation blocks, rebates, pockets, holes, thrust blocks to accommodate the installation of the plant and must be detailed on the drawings.

The Contractor shall before deliver any equipment to site, inspect and check the related building and civil works for accuracy and suitability of construction and for conformance with the Contractor's drawings.

Ensuring that holes through walls and floors have been done correctly will be the responsibility of the Civil Contractor, however the supply and installation of all foundation bolts and grouting of bases, supports or any other mechanical equipment shall be the responsibility of the Mechanical Contractor.

D52. TRAINING

D52.1. General

During the Trial Operation Period, the City of Cape Town's site staff will assist the Contractor in operating the plant and the Contractor shall train the staff in the starting, operating, troubleshooting and shutting down of the plant and shall train the City of Cape Town's maintenance staff on the maintenance requirements and procedures. On-Site personnel tuition of 10 operational staff members and 5 engineering staff members depending on the nature of the project.

The Contractor shall also provide the trainees with printed copies of the Operating and Training Manual (this extract shall include the functional description of the system(FDS), the control philosophy, the key operational set-points, details on the process and equipment safety interlocks as well as the installation's P&ID) which forms part of the Operation and Maintenance Manual.

D52.2. Operational Staff Tuition

The Contractor shall provide the following tuition as applicable to the Contract:

(a) Start-up, shut-down and operating instruction for all operational modes for the Works shall be provided. This shall be comprehensive and shall include actions to be taken in the case of all alarm conditions and basic fault finding.

(b) A layout drawing of the installation, a process flow diagram, and a P&ID shall be provided for each Operator. The instructions described in (a) above shall also be provided in printed form for each Operator.

(c) If the specified control system is SCADA based, the tuition shall include instruction on the SCADA system.

D52.3. Electrical Engineering Staff Tuition

The Contractor shall provide the following tuition as applicable to the Contract:

(a) Control system software instruction.

(b) Detailed overview of 11 kV protection and settings.

(c) Tuition on setting of 11 kV protection.

(d) Motor protection relay and settings.

(e) Overview of PLC programming for the purposes of making changes and re-loading programs if PLCs are replaced.

(f) Overview of SCADA system.

[redacted]

D53. SPARES

Spares which are specified in the Detailed Mechanical Specification shall be packed individually. Each box shall be labelled with the Contract number, manufacturer, contents, relevant part/model numbers and the supplier's address.

D54. OPERATING INSTRUCTIONS AND SIGNAGE

Operating instructions and signage, shall be part of all mechanical installation project requirements and shall comply with the requirements below.

D54.1. Operating Instructions

Wall mounted operating instructions shall comply with the following:

(a) Start-up, Shut-down and Operating instructions shall be provided. These shall be comprehensive and shall indicate actions to be taken in the case of all alarm conditions. These shall be written from the point of view of the plant operator.

(b) A layout drawing of the equipment installation, a process flow diagram, and a P&ID shall be provided.

(c) Instructions shall be laminated with hardboard backing. All instructions shall be included in Safe Operating Procedure format and form part of the O&M Manuals.

D54.2. Signage

Signs, photo-luminescent, 3mm white Perspex UV resistant, shall be provided by the Contractor in appropriate places on the walls of the plant room and include the following:

(a) All statutory and special safety warning instructions.

(b) Course of action during / after electrical shock.

(c) Any operating restrictions for equipment.

(d) Operating instructions in cases of plant trip and electrical supply failure.

Symbolic signs shall comply with SANS 1186.

The wording of the signs shall be approved by the Engineer prior to final printing. All signs shall cross refer, where applicable, to the relevant portion of the Manual.

All signs shall be installed prior to commissioning.

All signs 200mm x 200mm or larger in a wash down area shall be mounted on the wall using chemical mortar and secured with stainless steel ready bar and stainless steel nuts.

Non-wash down areas and signs smaller than 200mm x 200mm shall be secured using PVC fisher plugs with stainless steel coach screws.

For correct selection of mounting fasteners, preventing Bimetallic Reaction/Galvanic Corrosion, refer to: Design and Contracts – Quality Control Procedure 15: Bimetallic Corrosion Prevention.

Note: The following example layout drawings are available on request:

	Drawing Description		Drawing No.
1	Standard Construction Sign Board	(3600mm x 2850mm)	EAM-ME-SS-004
2	Common H&S Signage	(200mm x 200mm)	EAM-ME-SS-005
3	Sewage Pump Station Sign	(900mm x 500mm)	EAM-ME-SS-003

D55. OPERATION AND MAINTENANCE MANUALS

D55.1. Submission of Manual

Three draft copies of the Manual shall be submitted to the Engineer prior to commissioning the Works. One copy will be returned to the Contractor with comments. The second copy will be used by the operational staff on Site.

Six copies of the final version of the Manual, as accepted by the Engineer, shall be provided prior to the start of the Defects Notification Period.

[redacted]

D55.2. General Requirements

The Manual shall comply with the following:

(a) The Manual shall be for the complete Works and shall be of a standard acceptable to the Engineer. It shall be in English and shall be practically and neatly presented.

(b) One Manual shall contain original documents and this set shall be marked "Original". The other 5 Manuals shall contain all the information in the original and shall be marked "Copy 2" to "Copy 6".

(c) Binders shall have hard, plastic protected covers utilising four-ring, spring-clip holders. Binders shall not be overloaded. One spare, empty binder shall be provided for every three used. A title label shall be affixed to the spine of all binders. This shall indicate Contract number, title, Contractor's name, Site/Plant name, volume number and contents.

(d) Sections and sub-sections shall be titled, uniquely numbered and provided with separator sheets.

(e) Printed matter which is inserted in the Manual shall be arrowed (indelibly) to indicate the equipment installed.

(f) Drawings shall be to a scale which makes details clear. Large drawings shall be held in plastic envelopes in the Manual. A4 and A3 drawings may be bound as normal pages. Drawings shall also be provided on electronic data storage in AutoCAD, or equivalent, format.

(g) Location map, street address as well as GPS co-ordinates to be provided.

(h) Cross-referencing within the Manual is acceptable where duplication occurs.

D55.3. Format and Contents

The Manual shall be in accordance with the following (the Contractor shall modify, elaborate and repeat this format as required):

Electronic Format:

All information in the hard copy O&M manuals to be provided in soft copy on a USB flash discs (x6) with separate folders for each section including all material related to the particular section. Each section shall be saved as a separate PDF file, with a hyperlinked index sheet for sub-sections. This shall include drawings and maintenance schedules as separate files. In addition, the "Summary equipment and maintenance template" shall be saved in Excel format under Section 1. Contractor to ensure the latest Excel template is requested, used and completed.

All necessary software programs and passwords shall be provided.

No.	HEADING	CONTENT
1	**GENERAL**	
1.1	Contents List	Contents List for complete Manual.
1.2	Description of the Works	The description of the Works shall include a description of; firstly, the process; secondly, the design parameters and; thirdly, a detailed description of the equipment installation supported by drawings and process flow diagrams.
1.3	Equipment List	Equipment list containing each item of mechanical, electrical, instrumentation and control equipment. The equipment list shall include the make, model, serial number, description, size, range, performance data, motor and drive details, supplier's name, address and phone numbers, all as applicable. The design duty, the position of each unit's installation and its purpose in the system shall be given. Additional information which shall be provided for instruments includes the normal operating reading, maximum or minimum permissible readings, set-points (activation, warning and trip), etc. A separate list of all spares provided in terms of this Contract shall also be provided.

[redacted]

1.4	Drawing List	Drawing list of all the Contractor's drawings and the Tender drawings.
1.5	Cable Schedule	Cable schedule for power, data, control and instrumentation cables. This shall include the cable construction, conductor material, insulation, protection, voltage rating, start and finish points, route length, duty, load, voltage drop, core area, no. of cores, no. of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.
1.6	Documents	As-built system, layout and GA drawings. Plant circuit, flow diagrams and/or P&IDs. Control panel layouts. I/O list, program listing, loop and logic diagrams for each PLC. Colour prints of SCADA mimic screens, control faceplates and sequences. System control diagram and logic sequence chart. Copy of certificate of electrical compliance.
2	**OPERATION**	
2.1	Control System	Description of control system; including all manual and automatic controls. This shall include controls, instruments, protection list, settings, indications, alarms, trips, etc.
2.2	Commissioning	Commissioning Instructions. Commissioning report.
2.3	Operating and Training Manual	Operating and training manual. This shall include normal start-up, adjustment, operating and shut-down procedures and any emergency operating procedures. All specific safety aspects as well as settings, adjustments, observation, etc. shall be provided.
3	**MAINTENANCE SCHEDULES**	
	Maintenance and Lubrication	Schedule of routine maintenance, by time period, for all mechanical, electrical, instrumentation and control equipment. This shall be all-inclusive but reference to manufacturer's standard manuals in other parts of the Manual is acceptable. The schedule shall incorporate a lubrication schedule of recommended lubricants, capacity, lubrication periods, etc.
4	**MECHANICAL EQUIPMENT**	(This section shall be repeated for each item of equipment)
4.1	Identifying Information	Identifying information for the item; copied from the Equipment List.
4.2	Nameplate	A photograph of the nameplate and a table containing the unit's nameplate information.
4.3	Design and Operation	Details of operating principles, construction and operating instructions.
4.4	Maintenance Information	Technical and maintenance information including instructions for installation, assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.
4.5	Spares	A spares list giving the item number, part number, description, quantity and materials. A list of spares recommended to be held on Site.
4.6	Test Results	Factory and Site test results.
4.7	Corrosion Protection	Corrosion protection systems used, coating supplier's data sheets and coating repair procedures.
4.8	Documents	Performance curves. Large scale, dimensioned, cross sectional and arrangement drawings of the item for assembly and spares recognition purposes, cross-referenced to the

[redacted]

		spares list. Dimensioned drawings of fabricated equipment. Circuit layout of any auxiliary systems
5	**ELECTRICAL**	(This section shall be repeated for each item of equipment)
5.1 to 5.6	As for 4.1 to 4.6 for Mechanical Equipment (see above).	
5.7	Control Details	Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.
5.8	Documents	Electrical reticulation drawings. Equipment overall dimensions. Wiring diagrams. Switchboard layout drawings and SLDs. Electrical panel construction drawings.
6	**INSTRUMENTATION**	(This section shall be repeated for each item of equipment)
6.1 to 6.6	As for 4.1 to 4.6 for Mechanical Equipment (see above).	
6.7	Documents	Circuit diagrams of instrumentation systems and of individual instruments. Installation arrangement.
7	**CONTROL**	
7.1	Identifying Information	Identifying information for PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.
7.2	I/O List	Cross-referenced listing of all I/Os used.
7.3	SCADA	Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.
7.4	Program	Flash disk containing all software. An annotated program listing.
7.5	Documents	Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.
8	**DRAWINGS**	
	Drawings	All drawings not filed elsewhere shall be filed in this section.

D56. STARTING, SITE TESTING AND COMMISSIONING OF PLANT

D56.1. General

The Contractor shall advise the Engineer when instructions may be given to the Building Contractor to execute any necessary screening and finishing's around the Works. A reasonable period shall be allowed in the installation programme for commissioning work.

D56.2. Preparation

Installation work shall be complete and accepted by the Engineer prior to commissioning.

Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start with safety. The Contractor shall provide initial fill requirements, such as lubricating oil.

D56.3. Starting-Up and Testing

The Contractor shall arrange for the Engineer to be present at initial start-up and also for any electrical and control instrumentation sub-contractors to be present.

The Contractor shall start up and test each section of the Works. These tests shall be carried out

[redacted]

to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Engineer. All necessary modifications and rectifications shall be carried out during this period.

Set points for equipment and process parameters which are required for the operation of control systems shall be confirmed and recorded.

D56.4. SCADA System

During commissioning of a new installation which incorporates SCADA as part of the control system, each control system alarm and interlock shall be tested and the resulting alarm messages shall be modified by the Contractor to be acceptable to the Engineer.

A schedule of alarm messages and their full explanations shall be inserted in the Manual.

D56.5. Commissioning

When all tests have been completed to the satisfaction of the Engineer, the Works shall be commissioned. Unless the Engineer states otherwise, the complete plant, including all control functions and control systems shall be commissioned as a unit and the process performance requirements shall be achieved during normal operation.

D56.6. Trial Operating Period (TOP)

Once the Works has been commissioned to the satisfaction of the Engineer, the operational acceptance period shall start and shall consist of a continuous period of operation free from trouble – the trail operating period (TOP). Unless otherwise stated, the TOP shall be four weeks (28 days). During the operational acceptance period, the Contractor shall carry out all necessary servicing and any adjustments required. The plant staff will assist the Contractor in operating the Works during this period. The Contractor shall train the operational staff in the starting, operating and stopping of the Works, and shall train the maintenance staff on the routine maintenance requirements.

D56.7. Commissioning Report

A comprehensive commissioning test report, including the SCADA system commissioning procedure and schedule of alarm messages, shall be submitted by the Contractor prior to issue of the Certificate of Completion and shall be inserted in the Manual.

D56.8. Inspection

At the end of the Trial Operation Period, an inspection shall be done by the Contractor and the Engineer for the purpose of taking over the Works in terms of Clause 10 of the General Conditions of Contract.

D56.9. Defects Notification Period (DNP)

Refer to Clause 11 of the General Conditions of Contract and the Detailed Mechanical Specification for requirements regarding maintenance during the 365 day Defects Notification Period.

Reactive and proactive maintenance performed shall be captured by the Contractor and confirmed by the Senior Engineer. This communication shall be done in the following format:

- Date:
- Plant name:
- Location and GPS:
- Equipment reference / what failed:
- What is the damage:
- Causes of the damage:
- Repair time:

D56.10. DNP Report

The contractor shall provide the performance reports following commissioning (TOP) after:

- One (1) Month
- Three (3) Months



- Six (6) Months
- Twelve (12) months.



D57. STANDARD DRAWINGS

Standard drawings are available on request.

Table: List of Standard drawings

Item	Drawing Description	Drawing No.
1	6 Cube Skip	EAM-ME-SS-001
2	Four Legged Overhead Gantry Proposal - 500kg	EAM-ME-SS-002
3	Pump Station Signage Board - Example Standard	EAM-ME-SS-003
4	Standard Construction Signage Board	EAM-ME-SS-004
5	Common H&S Signage	EAM-ME-SS-005
6	Field Control Station For Push Buttons	EAM-ME-SS-006
7	Bell Mouth Design	EAM-ME-SS-007
8	Standard Penstock Example	EAM-ME-SS-008
9	Typical Steel+M16:M30 Door 1x800 Type A	EAM-ME-SS-009
10	Typical Steel Door 1x800 & 1x400 Type B	EAM-ME-SS-010
11	Typical Steel Door 1x800 & 1x400 Type B2 with Louvres	EAM-ME-SS-011
12	Typical Steel Door 2x800 Type C	EAM-ME-SS-012
13	Typical Steel Door 2x800 Type C2 Extended Height	EAM-ME-SS-013
14	Typical Steel Door 2x800 C3 with Louvres	EAM-ME-SS-014
15	N/A	EAM-ME-SS-015
16	GRP 3m Ladder	EAM-ME-SS-016
17	GRP Ladder Extension	EAM-ME-SS-017
18	GRP Ladder with Safety Cage	EAM-ME-SS-018
19	Steel Ladder Extension	EAM-ME-SS-019
20	Steel Ladder with Safety Cage	EAM-ME-SS-020
21	Pressure Gauge and Pressure Transducer Arrangement	EAM-ME-SS-021
22	Standard Skip Bogey Wheel	EAM-ME-SS-022
23	Standard Manhole Lock 1000mm	EAM-ME-SS-023
24	Standard Manhole Lock 1500mm	EAM-ME-SS-024
25	Standard Pipe Support 250mm High	EAM-ME-SS-025
26	Standard Pipe Support 500mm High	EAM-ME-SS-026
27	Standard Pipe Support 1000mm High	EAM-ME-SS-027
28	Standard Aircon Cage Detail	EAM-ME-SS-028
29	Standard Drive Sheer Pin M12	EAM-ME-SS-029
30	Standard Handrail Stanchions	EAM-ME-SS-030
	Flow Straitner	ME-A4/1520

Other Departments / Branches

Item	Drawing Description	Drawing No.
	Bulk Water	
	Valves	W&S-BW015:1993

[redacted]

D58. QUALITY CONTROL PROCEDURES

QCP's are available on request:

All completed QCP's to be included in the final copies of the O&M manuals.

Ensure that the latest available version is used.

Table: List of Quality Control Procedures

Technical		
	QCP Description - Electrical	QCP No.
1	Application for New Electrical Supply	EAM/D&C/QCP/001
2	Generator Factory Inspection Checklist	EAM/D&C/QCP/002
3	Generator Factory Inspection Checklist	EAM/D&C/QCP/003
	QCP Description - Mechanical	QCP No.
11	Pipework Fabrication Inspection	EAM/D&C/QCP/011
12	Corrosion Protection: Galvanising Inspection	EAM/D&C/QCP/012
13	Penstock Inspections	EAM/D&C/QCP/013
14	Steel Door Inspections	EAM/D&C/QCP/014
15	Bimetallic Corrosion Prevention	EAM/D&C/QCP/015
16	Pump Performance Testing ISO 9906	EAM/D&C/QCP/016
17	Works Package Scoping	EAM/D&C/QCP/017
18	Gearbox QCP	EAM/D&C/QCP/018
19	Low Voltage Motor Inspections	EAM/D&C/QCP/019
20	Lifting Equipment	EAM/D&C/QCP/020
Procedural		
	QCP Description	QCP No.
21	General Commissioning Procedure	EAM/D&C/QCP/021
22	Pump Commissioning Checklist	EAM/D&C/QCP/022
23	Pump Performance Monitoring	EAM/D&C/QCP/023
24	Capital Project Planning - Key Stakeholder Questionnaire	EAM/D&C/QCP/024
25	Design & Contracts Project Closure Checklist	EAM/D&C/QCP/025
26	O&M Manual Review Checklist	EAM/D&C/QCP/026
27	Request for Quotation Checklist	EAM/D&C/QCP/027
28	MV Inputs Assistance	EAM/D&C/QCP/028

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CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.

STANDARD SPECIFICATIONS FOR ELECTRICAL WORKS

DIRECTORATE: UTILITY SERVICES

DEPARTMENT: WATER AND SANITATION

CITY OF CAPE TOWN

Recent Input	Approved by	Date Approved
[redacted]	[redacted]	.....

VERSION: 2022

[redacted]

Change List: Existing Section Headings Updated

Updated Section and Page No	Section Heading	Summary of Updates
iii	GLOSSARY	Updated acronyms
4 Page 4	LOCKS	Rearranged
7 Page 6	SWITCHBOARD STANDARD	Has now shifted because of new section 5
7 Page 14	Switchboard Standard Colours	Added a colour
12 Page 26	Overload relays	Wording changed
16 page 38	Security Alarms	Updated with the latest spec
16 page 42	Pad Locks	A preferred pad lock
26 Page 59	SPECIALISED PROCESS CONROL SYSTEMS	Updated with the latest spec, 26.10
26 Page 59	Optical Fibre Cables	Moved to this section, see 26.10
27 Page 93	Telemetry Systems	Rearranged and grouped under one section
47 Page i	Appendices	Drawings List
20 Page 49	MV Specifications	Removed MV Specifications following this section

New Section Headings added

New Section and Page No	Section Heading	Summary of Updates
5 Page 5	WAYLEAVES	Added Wayleave process
42 on page 94	STARTING, SITE TESTING, IINSPECTIONS, MEETINGS AND COMMISSIONING OF PLANT	Defects notification and starting added
16.7 on page 42	WET WELL LIGHTING	New section
16.8 on page 43	SECURITY ALARM SYSTEMS	New section on Pepper spray

[redacted]

GLOSSARY

Terms Definitions and Abbreviated Terms

ACRONAME	DEFINITION
BS	British Standards
CDA	The Core Development Area as defined in the DFPR
CDC	Coega Development Corporation
Eskom	South Africa's main generation and bulk supply authority
IEC	International Electro technical Commission
ISO	International Standards Organisation
HV	High Voltage (132kV)
LV	Low Voltage (400/231V)
MV	Medium Voltage (1kV-33kV)
NRS	National Rationalised Standards
OHS Act	Occupational, Health and Safety Act and Regulations (Act 85 of 1993)
RED	A Regional Electricity Distributor in terms of the latest proposals for the restructuring of the Electricity supply industry.
SABS	South African Bureau of Standards
SANS	South African National Standards
SCADA	Supervisory, control and data acquisition.
CCTV	Close Circuit Television
EAM	Engineering Asset management
PCC	Point of Common Coupling
DC	Direct Current
AC	Alternating Current
MCC	Motorized Controlled Centre
kA	kilo Amperes
PLC	Programmable Logic Controllers
DB	Distribution Board
AISI	American Iron and Steel Institute
PVC	Poly(Vinyl Chloride)
LED	Light Emitting Diodes
UPS	Uninterrupted Power Supplies
CVT	Capacitive Voltage Transformer
HMI	Human Machine Interface
CPU	Central Processing Unit
I/O	Input / Output
SSR	Solid State Relay
RTU	Remote Terminal Unit
USB	Universal Serial Bus
PCS	Process Control Systems
PIR	Passive Infrared Sensors
PFC	Power Factor Correction



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[redacted]

1 GENERAL

1.1 SCOPE OF WORKS

The Scope of Works shall be as per this Detailed Electrical Specification.

1.2 SITE CONDITIONS

The Tenderer shall take cognisance of the fact that the plant is currently in operation and a minimum disruption to the operation is required.

Motor manufacturers, switchboard manufacturers, electrical equipment manufacturers, are all warned that the motor and associated control equipment are to be installed in an extremely corrosive and often damp environment. The motor and allied equipment shall therefore be adequately protected

2 STATUTORY REGULATIONS PERTAINING TO ELECTRICAL WORK

Except where otherwise specified or implied the contract work and equipment supplied shall comply with the **latest revisions** of the standard specifications listed, including generally:

a) SANS 10142-1 The wiring of Premises, Part 1: Low voltage installations
b) SANS 10400-2 The Application of the National Building Regulations, Part A: General principles and requirements
c) Local Fire Regulations
d) The Regulations of the Local Supply Authority
e) The Regulations of the Department of Posts and Telecommunications

Where a SANS Standard does not exist or if not applicable, the relevant IEC or BS Standard shall be applicable.

The equipment supplied and work carried out shall fully meet and comply with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations 2003 issued in terms of Section 43 of the Act, Standards South Africa (a Division of the South African Bureau of Standards {SABS}) and all other statutory regulations and laws insofar as they may apply to an electrical installation of the type contemplated.

In the event of discrepancy between any of the specifications, regulations and codes of practice, the SANS 10142-1 Code of Practice for Wiring of Premises shall take precedence.

All references to "SABS" specifications shall be read as "SANS" in light of the recent changes by the South African Bureau of Standards.

Additionally, the following specifications, whether specifically mentioned within the tender document or not, shall also apply:

STANDARD CODE	DESCRIPTION
SANS 10111-1:2011	Engineering Drawings, Part 1:General Principles
SANS 1091:2012	National colour standards
SANS 156:2007	Moulded case circuit breakers
VC8036:06 Oct 2006	Compulsory specification for circuit breakers
SANS 60269-1	Low-voltage fuses, Part 1: General
SANS 60269-4	Low-voltage fuses, Part 4: Supplementary requirements for fuse-link for the protection of semiconductor devices
SANS 950	Unplasticised polyvinyl chloride rigid conduit use in electrical installations
SANS 1507-1	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V), Part 1: General

[redacted]

STANDARD CODE	DESCRIPTION
SANS 1195	Cover plate
SANS 60439-1	Low voltage switch-gear and control gear assemblies, Part 1: Type-tested and partially type-tested assemblies
SANS 60439-2	Low voltage switch-gear and control gear assemblies, Part 2: Particular requirements for busbar trunking systems (busways)
SANS 1973-1	Low voltage switch-gear and control gear assemblies, Part 1: Type-tested assemblies with stated deviation and a short-circuit withstand strength above 10kA
SANS 1973-3	Low voltage switch-gear and control gear assemblies, Part 1: Safety of assemblies with a rated protective short-circuits up to and including 10kA
BS 4070	Performance of A.C. control gear equipment rated up to 660 V for use on high prospective fault-current systems
BS 587	Motor starters and controllers
SANS 60947-1	Low voltage switch-gear and control gear assemblies, Part 1: General rules
SANS 60947-2	Low voltage switch-gear and control gear assemblies, Part 2: Circuit-breakers
SANS 60947-3	Low voltage switch-gear and control gear assemblies, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
SANS 60947-4-1	Low voltage switch-gear and control gear assemblies, Part 4-1: Contactors and motor starters – Electromechanical contactors and motor-starters
SANS 60947-4-2	Low voltage switch-gear and control gear assemblies Part 4-1: Contactors and motor starters – AC semiconductor motor controllers and starters
VC8011: 9 July 1999	Compulsory specification of Lamp holders
SANS 475	Luminaires for interior lighting, street lighting and floodlighting – Performance requirements
SANS 10114-1	Interior lighting, Part 1: Artificial lighting of interiors
SANS 10222-5-1-3	Electrical security installations, Part 5-1-3: CCTV installations - CCTV surveillance systems for use in security applications - Installation, planning and implementation requirements.
SANS 60793-1-1 Optical fibres, Part 1-1:	Measurement methods and test procedures - General and guidance
SANS 60794-1-1	Optical fibres cables, Part 1-1General specification – General
SANS 675	Zinc-coated fencing wire
SANS 1373	Chain-link fencing and its wire accessories
SANS 10131	Above-ground storage tanks for petroleum products
SANS 780	Transformer Testing

[redacted]

STANDARD CODE	DESCRIPTION
SANS 1084-1/2	Electric Motor Standards
SANS 10131	Above-ground storage tanks for petroleum products
SANS 10198	The selection, handling and installation of electric power cables of rating not exceeding 33 kV

3 DRAWINGS

3.1 List Of General Specifications Standard Drawings

Drawings listed in Appendix-A at the end of this specification can be electronically made available in pdf. These may be requested from Design and Contracts Drawings Officer and his email address is:

MogammatRaeez.Hendricks@capetown.gov.za

3.2 Engineer's Drawings

The Engineer's drawings shall be as listed in the Project Specification.

3.2.1 Contractor's Drawings

Workshop drawings of proposed Motor Control Centres, Field Control Stations, Local

Distribution Boards, as well as any other switchboards are required for approval by the Engineer prior to fabrication.

Record drawings (previously termed "as-built"s) of the installation indicating cable routes, sleeve positions and circuit wiring details are required on completion. All these record drawings must be checked and signed by the sub-contractor before submission to the Engineer.

A full set of schematic drawings and wiring diagrams shall be handed over at the end of the Contract; including all switchboards, motor control centres, distribution boards, field control stations etc.

The Contract will be deemed incomplete until the Contractor has handed all these drawings over to the Engineer who shall provide his final acceptance in writing.

4 LOCKS

The Tenderer shall supply locks whilst completing the work at hand. The City of Cape Town shall supply locks for all the equipment on completion of commissioning.

4.1 Lockout Procedure/Permit To Work Form

The Directorate: Water and Sanitation of City of Cape Town has implemented a system whereby any party entering and/or proposing to undertake any electrical works on any of its premises or sites, is issued with a permit to undertake work, which is available from the respective Plant Manager etc. Work MAY NOT be undertaken in any form or context if this permit is not issued and validated by the Authorised personnel onsite.

Any and all low voltage (below 1000 Volts) work onsite at any of City of Cape Town's premises requires a written Permit to Work to be issued by the Facility Manager at a respective site or their duly appointed representative.

[redacted]

4.2 Medium Voltage Switching Operations

NO MEDIUM VOLTAGE SWITCHING OPERATION shall be performed by any non-City of Cape Town personnel.

Only the City of Cape Town personnel, as permitted in writing by the Engineer or the Medium Voltage Maintenance Manager, may perform Medium Voltage Switching Operation.

The Design and Contracts Engineer allocated to the project will be the only liaison person between the Consultant or Contractor and Medium Voltage Maintenance Manager in this regard.

5 WAYLEAVES

Any work onsite at any of the City of Cape Town's premises requiring excavation shall not be carried out without a wayleave. For example, an excavation of cable trenches requires a Wayleaves to be issued by the relevant stakeholders whose services will be affected.

Eskom in the Eskom supplied areas, City of Cape Town's Energy Generation & Distribution in areas supplied by the City, and Water & Sanitation within its Facilities will issue the wayleave.

Where infrastructure As-Built drawings do not exist in a particular facility (a pump station or a treatment plant), the contractor shall identify electrical services using a device with either a built in GPS or GNSS receiver or a device that can interface via Bluetooth or wired connection with GIS mapping system.

The contractor shall record the areas where services are identified, produce a document which maps where the affected services were intercepted, labelling the coordinates on the map. The contractor shall make a wayleave application to Design and Contracts in the interim (while a formal process is being workshopped), attaching their cable identification report. This Wayleave shall be reviewed and endorsed by the Engineer or his duly appointed representative

6 VOLTAGES

6.1 Supply Voltages

Supply voltage shall be 400V, 50Hz, 3 Phase with full Neutral (see Busbars and Wiring below).

6.2 Permissible Voltage Drop

Unless otherwise stated, the permissible voltage drop within low voltage installations from the Point of Common Coupling (PCC) shall be calculated as follows:

a) "1v plus 2% of the voltage at the end of the circuit when the entire circuit is fully loaded".

b) The PCC on low voltage installations shall be the respective transformer low voltage terminals.

6.3 Control Voltages

Control Voltages within Switchboards shall be deemed to be 110 - 240 V AC / 24V DC (Or as detailed in Project specification). Control voltages for remote field equipment, for example Start/Stop stations, shall be 230V AC. If an existing installation is to be expanded, the existing control voltage shall be maintained.

Refer to Drawing EAM-EE-GS-031 for drawing entitled "Typical LV Starter Panel Schematic 230VAC/24VDC Control".

[redacted]

7 SWITCHBOARD STANDARDS

Includes but not limited to motor control centres, distribution boards, trays and boxes.

7.1 GENERAL

The manufacture of LV Switch-gear and Control gear ASSEMBLIES also referred to as motor control centres (MCC's) and distribution boards (DB's) {both collectively referred to as in this specification as "ASSEMBLIES" or "switchboards"}, shall be "Type Tested" modular type distribution boards and shall strictly comply with the latest revisions of the following standards:

SANS 60439-1	LV Switch-gear and Control gear ASSEMBLIES, Part 1: Type-tested, Partially Type-tested ASSEMBLIES'.
SANS 60439-2	LV Switch-gear and Control gear Assemblies, Part 2: Busbar Trunking'
SANS 1973-1	LV Switch-gear and Control gear ASSEMBLIES, Part 1: Type-tested, ASSEMBLIES with stated deviations and rated short-circuit withstand strength above 10kA.
SANS 1973-3	LV Switch-gear and Control gear Assemblies, Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10kA.

For ASSEMBLIES equal to or greater than a 10kA rating, switchboard manufacturers shall be in possession of a minimum of the test reports required as defined in SANS 1973-1.

Only authorized holders of these test reports may design and construct the ASSEMBLIES.

Copies of relevant test reports shall be made available to the Engineer immediately upon request.

Should this information not be presented to the Engineer upon request, Engineer reserves the right to call for another manufacturer to supply equipment that complies with this requirement and no compensation in any form shall be granted to the non-compliant party.

Notwithstanding any requirements of SANS 1973-1, the manufacturer of the ASSEMBLY (including the busbar assembly and mounting), shall re-torque the busbars onsite once fully populated and connected-up, prior to switch-on, and shall issue a certificate to the Engineer detailing that the bus-bar arrangement is still to the same standards as at the time of initial construction and is safe for operation.

Suppliers/Manufacturers of switchboards shall be in possession of a Permit to Apply the Certification Mark, issued by the South African Bureau of Standards, in terms of the Specific Permit Conditions of SANS 1973-1 and SANS 1973-3.

ASSEMBLIES shall be fitted with a metal label, clearly displayed, detailing the information required by SANS 1973-1 and SANS 1973-3 as applicable.

7.1.1 MCC Preferred Design Requirements

The following switchboard requirements shall be assumed as correct unless altered in the Project Specification:

MCC Key Item	Requirement
Mounting	Floor standing
Access	Front and rear access
Sectioning	Multi-section, Form 3b or Form 4 to SANS IEC 60439
Manufacture	2.0 mm and 1.6 mm 3CR12 or Aluzinc (see Fabrication below)
Finish	Painted Light Orange – B26 (SANS 1091:2012) external, White arc-free internal (see Painting and Finishing below)

[redacted]

MCC Key Item	Requirement
Cable Entry	Incoming & Outgoing – bottom MCC gland plates shall be 3CR12 or Aluzinc sheet steel, unpainted or aluminium (see Glanding Section below).
Base	Single 100x50x6mm thick channel iron base with mitred corners and cross-bracing between every 2nd tier, hot-dipped galvanised. 350mm high base with flow through ventilation grating or grills for kiosk type control panels mounted over or near an aggressive environment
Doors	Lockable (see Doors and Covers below)
Protection	IP44 (panels fixed); IP12 (panels removed)
Functional Units:	Removable but not fully withdrawable
Electrical Details:	400V, 50Hz, 3 Phase with full Neutral (see Busbars and Wiring below).
Earthing Details:	Full length, rear of switchboard (see Earthing below). All earthing bars to be tinned copper.
Electrical Ratings:	MCC Fault level to be to Transformer Secondary Output Symmetrical fault level, 3 second rating, applicable to Main and Distribution busbars. (See Project Specification for specific values and electrical loading requirements)
Dimensions:	Height : 2100mm (max) Depth : 400mm/600mm (standard)/800mm Cubicle Size (minimum) : Or Cubicle/Door Panel Spacing Cubicle/Door Panel Spacing

Note that cubicle height may be 385mm provided that the width is greater than 600mm.

An 800mm wide cubicle may be divided into 2 x 400mm cubicles (minimum 600mm cubicle height).

(Cubicle sizes may vary but only subject to written approval by the Engineer)

Positioning and Clearances: Switchboards (free standing) are to be positioned within existing or proposed switch rooms such that the following

Clearances are maintained:

a)	At rear of switchboard	1000mm
b)	At each end of the switchboard	1000mm
c)	In front of switchboard	2000mm
d)	On top of switchboard	700mm (bottom entry panels)
e)	On top of switchboard	900mm (top entry panels)

The Engineer shall be the sole arbitrator in disputes relating to adherence to these and the general technical specification standards.

7.1.2 Hold Points during Manufacturing

The following hold points require action and shall be adhered to prior and during the manufacturing process. Each step shall be completed in turn, requiring an inspection of the switchboard at the manufacturer's premises and requiring the written acceptance of the Engineer for each step, prior to acceptance:

a) Distribution Board Design
b) After manufacture of metal work, prior to painting

[redacted]

c) After painting, prior to installation of equipment (switch-gear etc.).
d) Prior to delivery to site (at the sole discretion of the Engineer who may call for on-load
e) Testing in the manufacturer's workshop

Should these points not be followed and the item in question proves to be incorrect, it shall be for the manufacturer/tenderer/contractor to undertake to rectify the snags at their own cost.

7.1.3 Switchboard Preferred Tier Arrangement/Layouts

a) Switchboards are to generally comply with the following, but these guidelines may be altered due to the specifics of the installation:
b) For switchboards with a single incomer, this cubicle and tier shall be positioned on the entrance side of the switch room
c) For switchboards with a single incomer and a generator incomer, these cubicles and tiers shall be positioned in the middle of the switchboard.
d) For switchboards with two incoming mains feeders as well as optional and generator supplies, these cubicles and tiers shall be position in the middle of the switchboard.
e) PLC and Instrumentation dedicated Tiers shall be positioned within the switchboard on the side furthest from the entrance.
f) Bus-section switches shall be position in the middle of the switchboard adjacent to incomer tiers and cubicles.
g) Redundant/duplicated equipment shall be positioned on either side of a bus-section where practical.

7.1.4 Grouping of Equipment

Each motor circuit shall be individually protected by a circuit breaker dedicated to the respective motor circuit. A single circuit breaker protecting multiple motor circuits will not be permitted.

Only one motor drive per cubicle is required. Where motors operate as a single group, these shall be controlled as a single motor.

A motor drive cubicle which houses multiple motor drives shall only be permitted, when all the motor drives in the group are dedicated to a single item of equipment and all the motors operate as a group. When a single motor, within any one group of motors which has been selected for automatic operation, trips or is isolated, all the motors within the group shall stop and shall be prevented from being restarted by electrical interlocking.

7.1.5 Door Interlocking on Switchboards

A circuit breaker shall provide the means of isolation to each motor drive cubicle, or a cubicle housing a group of motor drives which forms part of the MCC. The operating lever, of the circuit breaker mounted within the cubicle, shall be coupled to an operating handle fitted to the cubicle door and interlocked such that the door may not be opened with the circuit breaker in the "on" position. The operating handle shall be padlockable in the "off" position. Auxiliary contacts shall be provided, on the circuit breaker, to isolate the control circuit.

Refer to OHS Act (Act 85 of 1993), Section 14 "Electrical Machinery Regulations" Clause 6(3)

"Electrical Control Gear", which states:

"The user shall, whenever reasonably practicable, provide switch-gear with an interlocking device so arranged that the door or cover of the switch cannot be opened unless the switch is in the "off" position and cannot be switched on unless the door or cover is locked".

[redacted]

7.1.6 Interlocking

Further to Clause above entitled "Switchboard Preferred Tier Arrangement/Layouts", the following electrical interlocking example, with 2 x Incomers and 1 x Generator, depicts the preferred arrangement to avoid paralleling of equipment:

SWITCH	A	B	C	D
Incomer Transformer No 1	Closed	Closed	Open	Open
Bus-Section No 1	Open	Closed	Closed	Closed
Incomer Standby Generator	Open	Open	Open	Closed
Bus-Section No 2	Open	Closed	Closed	Closed
Incomer Transformer No 2	Closed	Open	Closed	Open

Note this arrangement shall preferably be electrically implemented via a PLC or mechanically via the use of keys. However, should the electrical option be implemented, each circuit breaker shall be fitted with a separate lock out key. The preferred systems for key locking equipment shall be Keyguard, Ronis or Keymaster (Allen Bradley) or equivalent and approved Key Interlocking systems.

These combinations will provide the following, and only the following, arrangements:

A Busbar 1 fed from Transformer No 1; Busbar 2 fed from Transformer No 2
B All busbars fed from Transformer No 1
C All busbars fed from Transformer No 2
D All busbars fed from Standby Generator

Refer to project specification for specific details as to circuit breakers being motorized or not. √

7.1.7 Fabrication

All electrical motor control centres (MCC's), distribution boards (DB's), sub-distribution boards (SDB's), boxes, trays, covers or any other enclosure housing electrical apparatus supplied, shall be fabricated from AISI SX 3CR12 or Aluzinc sheet steel only, unless stated a better corrosive material is available and has been workshopped by Design and Contracts.

The tenderer/contractor/manufacturer shall take cognisance that MCC's and DB's shall in their entirety be manufactured from 3CR12 or Aluzinc sheet steel. This shall include all framework used to form the structure of the panel. Angle iron or tubular structures shall not be permissible.

Outer panels, doors, covers, rails, distribution board framework etc. shall be manufactured from 2mm thick 3CR12 or Aluzinc sheet metal and 1.6mm thick 3CR12 or Aluzinc sheet metal for internal partitions.

The sheet steel shall be suitably bent, braced and welded where necessary to form a rigid structure (this sheet metal shall be 3CR12 or Aluzinc only). Holes, doors, covers, rails, framework, etc. shall be accurately formed to present a true to line and plumb structure when completed. Where welding is necessary the inevitable excess material shall be ground down to the parent surfaces to present a blemish free surface for painting.

All screws employed in the manufacture of the electrical cubicles shall be in AISI 316 material with machine threads. No self-threading screws or self-setting rivets (pop rivets) will be permitted. Where the thickness of material for screw tapping is less than 5 x screw pitch, an externally knurled, threaded insert shall be installed to accept the machine screw. The insert shall be fitted with a hydraulically operated tool, and properly clinched, to ensure it will not rotate in the sheet steel, even when subjected to a torque of 200% of the torque required to shear the fitted screw. The inserts shall also be manufactured from AISI 316 stainless steel.

Alternative methods of providing suitable screw anchorages in sheet steel may be considered, such as captured or welded nuts, but the detailed alternatives shall be submitted for consideration at the time of tendering.

[redacted]

Each tier shall be divided into compartments to accommodate equipment for motor drives, instrumentation, and switch-gear for main and sub-main feeder switches.

Each compartment of MCC's or larger DB's shall be totally separated from adjacent compartments with 1.6mm sheet steel (3CR12 or Aluzinc) barriers welded or bolted into position and where wiring is required to pass through these barriers, brass brushed holed shall be provided.

Panel tiers to be bolted together and not welded.

Accessible PVC wire ways shall be provided to afford routes for conductors between the various compartments of each switchboard/MCC. Internal wiring shall be kept separated from external wiring and as far as possible the internal serving of PVC PVC SWA PVC cables entering the switchboard/MCC shall be left around the conductors until the cable enters the compartment to which it is to be connected.

Low current and instrumentation/signal cables shall be kept separate from other cables right up to the point where the conductors are connected to the required terminals on the apparatus. Accordingly, where required, separate sheet steel (3CR12 or Aluzinc) wire ways shall be provided in each board to ensure this separation.

All instrumentation and signal cabling shall be routed via galvanised conduit within the MCC.

7.1.8 Busbars and Busbar Chambers

Totally enclosed busbar chambers shall be provided though out the length of the MCC or DB. The busbar chamber shall have front, back, top and end covers.

The front and back covers shall be secured with square hatch keys, with one catch per cover lockable by padlock. The top and end covers shall be bolted.

The busbar chambers shall be so positioned in the MCC or DB at the top that each and every connection is easily accessible and sufficient space is provided to easily operate a torque wrench on each and every bolt/nut.

Dielectric barriers shall be provided in the busbar chamber at 2 x tier module. The dielectric may not be split and offered into position as separate parts but shall instead be slotted to allow the busbars to pass through. The slotted holes shall be fitted with U-shaped rubber gasketting to ensure the busbar is snugly fitted to the dielectric. These dielectric barriers may not be employed to support the busbars. The dielectric shall be bolted to the sheet metal at the periphery of the busbar chamber.

The penetrations for circuit into or out of the busbar chamber shall also be provided with dielectric material at the point of penetration, as for the busbar chamber barriers.

Busbar supports shall comprise moulded epoxy insulators mounted on robust steel brackets arranged in stepped formation with the red-phase busbar at the top rear of the chamber and the neutral busbar at lower front position.

All busbars shall be tinned over the full length using only resin-based flux and fitted with phase colour co-ordinated identification markings.

Joints in busbars shall be avoided as far as possible, but where they are necessary the joint shall be formed by offsetting one of the bars, by an amount equal to its own thickness, to overlap the other. The length shall be equal to twice the width of the bar, and the joint shall be secured with a minimum if 4 Hexagon headed set screws nuts and washers (plain and spring).

All busbar joints shall be torque tightened before the switchboard (MCC or larger DB) is delivered, and torque checked (and tightened if necessary) just prior to commissioning.

Each joint or point of connection shall be properly tinned. Only resin based fluxes shall be employed during the tinning process.

The busbar riser sections, onto which cables terminate, shall be considered as part of busbar system as a whole and shall be equally subject to all the specifications detailed.

[redacted]

Busbars shall be capable of carrying the full rated current along their entire lengths. Reduced section busbars will not be permitted. Busbars shall be designed for a maximum temperature of 70°C (i.e. a 40°C temperature rise in an ambient of 30°C). Where a transformer feeds directly to the busbar (via a main circuit breaker), the copper busbar shall be designed for 125% of the transformer output (in kVA) and shall be rated to withstand an internal or external fault for 3 seconds without incurring any damage.

The neutral busbar in the MCC or any DB shall be equal in size to the busbars and shall be considered as part of the busbar system.

Busbars shall be manufactured from 99% electrolytic copper that has been hard drawn to the finished sizes. The copper shall be rectangular in cross section, shall be solid, and the cross section shall be maintained throughout the busbar system. Where the copper is delivered with rounded corners the copper shall be suitably de-rated for thermal emissivity. The copper shall be supported on SANS approved insulators at centres which are commensurate with the fault level to which the busbar system has been designed, but in no instance shall they be greater than 500mm apart. Where it becomes necessary to employ more than 1 copper bar per phase the copper bars shall be of equal cross section and shall be properly spaced by an equal thickness spacer between the copper bars. Only copper having a cross section of 100mm x 6mm, or greater, may be employed in parallel, per phase.

The spacers shall be bolted into position at points of attachment for lugged conductors or droppers. Where joints in the copper bar are inevitable they shall be made by offsetting one bar by the thickness of the copper such that the copper bars overlap one another, at the joint, by the width of the copper. Joints shall be properly fastened together with hexagon headed bolts, full size nuts, spring and flat washers. At least 2 and not more than 3 threads shall be visible beyond the nut once the final torque has been applied to each fastener. Where copper is punched or drilled the inevitable burr shall be removed and the copper shall be lightly chamfered at each hole.

The busbars shall be provided with holes at either end of the switchboard to allow for an extension to the copper bar at some future time, together with centrally located holes in the copper bars, between the insulting supports to allow for future loads to be added where required. At least two such sets of holes shall be provided, between consecutive supports along the busbar length. If more than one copper bar per phase is being employed then a copper spacer shall be provided between the copper bars and a bolt shall be provided to secure the spacer at each of the "spare-hole" positions. All copper shall be tinned with S6 solder using resin based flux, after all the drilling, bending and cutting has been completed. The finished, tinned copper, shall be free of solder lumps and shall be as smooth as the copper under the solder.

7.1.9 Wiring, Cable Terminations and Glanding

All wiring within panels may be enclosed in PVC slotted ducting. The exception is signal and instrumentation cabling passing through power compartments or cubicles, which shall be in galvanised screwed conduit. Wiring outside of panels and switchboards shall be run within galvanised ducting or conduit.

Alternatively, signal and instrumentation wiring may be run in a channel at either the front or the rear of the busbar chamber, accessible from that respective side of the switchboard within the busbar chamber. The channel shall be manufactured of 3CR12 or Aluzinc and shall be welded into position. The channel shall contain a cover that is screwed into position.

All wiring and terminations shall be labelled with identification tags corresponding to the wiring diagrams. Cable terminations shall be marked with an identification label externally to the switchboard indicating the source of supply as well as the equipment being fed for feeder cables. For example: "FED FROM MCC 1" and "SUPPLY TO SUMP PUMP".

All glands for cable shall be nickel-plated brass, and fitted with waterproof neoprene shrouds.

[redacted]

7.1.10 Earth Bars

The earth bar shall be mounted at the rear of the MCC or DB and shall be accessible along its length from all tiers (where applicable). The earth bar cross-section shall be as specified, or, where not specified, shall be installed as per the minimum specified in SANS 10142-1 or SANS IEC 60439. Notwithstanding these requirements, the earth bar shall be not less than 70mm x 8mm in cross-section.

A one-piece copper earthing bar shall be installed from one end of the board to the other and shall be provided with earthing studs (nuts, bolts and washers) in each tier

The copper bar shall be bolted to the framework of the board in at least 10 positions with 10mm bolts. The copper bar shall be mounted 100mm above the top edge of the channel iron base and approximately 100mm from the backplate. Holes shall be provided in the copper bar in each cubicle along the length, for the termination of the earthing conductors associated with the circuits deriving a supply from the respective cubicles. Spare studs amounting to 10% of the Contractors requirements, shall also be provided. Bunching of earthing conductors on a single stud will not be permitted.

7.1.11 MCC and DB Bases

The floor mounted MCC or DB, shall be mounted to a hot dipped galvanised channel iron base, located at the position indicated in the transformer room. The base shall be fabricated from 100 mm x 50 mm x 6 mm (10,57 kg/m) channel iron. The corners of the base shall be mitred and welded whilst cross bracing shall be provided on centres coincident with the cubicle modules along the length of the base.

MCC bases for kiosk type control panels mounted over or near an aggressive environment such as pump station motor control panels, shall be mounted on top of a 350mm high base with flow through ventilation grating or grills. The bottom of the MCC part of the panel is closed off by the glanding plate and cable glands ensuring no gas ingress into the panel

Each cubicle shall be secured to the base with at least four 10 mm diameter bolts, washers and nuts whilst the base shall be anchored to the concrete with a bolt in each corner and two bolts at every even numbered cubicle module. (One at the front of the base and one at the rear). The anchor bolts shall be 12 mm diameter and shall be entered at least 80 mm into the concrete.

The widths shall be uniform throughout their heights and the plan view of the switchboard shall be uniformly rectangular in shape.

7.1.12 Paint and Finishing

All metalwork in excess of 5 mm thick shall be sandblasted to a profile of 40-80 microns, prior to painting. This finish shall be carried out carefully to provide the necessary "key" for the paint coats.

Where the material is less than 5 mm thick, it shall be, lightly sanded, de-greased, washed and forced air dried prior to painting.

The paint coat shall be a high quality polyurethane based powder coat to the acceptance of the Engineer. The sprayed powder coat shall be baked in an oven at a temperature of approximately 200°C for a period of 10 min or as specified by the paint manufacturers.

The dry film coat shall be as uniform as possible but shall not be less than 40 microns nor more than 90 microns. The finish shall be high gloss with a minimum of surface defects.

Distribution boards, boxes, trays, covers, ducts, or any other enclosure housing electrical apparatus shall be coloured white internally, whilst externally the colour shall be Light Orange to SANS 1091 or to the approval of the Engineer.

Switchboards connected for dedicated emergency supplies shall be coloured red externally.

[redacted]

7.1.13 Glanding Sections and Cable Gland Plates

Gland plates shall be fitted in cubicles for termination of cables and shall be mounted 400mm above the final floor level. The cables shall be fitted with glands anchored to the respective gland plates. The glands shall be adequately spaced to permit the locknuts to be tightened with normal tools.

The gland plates shall be at least 2mm thick, 3CR12 or Aluzinc sheet steel or aluminium and shall be bolted to robust brackets welded to the framework of the board.

At positions where single core cables are employed the cable gland shall be fabricated from non-ferrous material of adequate thickness to support the cables i.e. 15mm thick TUFNOL, 5mm 316 stainless steel or 8mm aluminium.

7.1.14 Doors and Covers

A door shall enclose the front of each compartment, unless stated otherwise in the project specification.

Enclosures for outdoor or moist environments shall be provided with a weatherlip angled at 45° to the face of the enclosure framework, together with a door enclosing the cubicle and enveloping the weatherlip. The top of the outdoor enclosure shall be fitted with a full width canopy projecting at least 100 mm from the enclosure face.

All doors shall be arranged to stand off from the face/rear of the board, cubicle, compartment or enclosure. Each door shall be properly stiffened and shall be twice returned at the periphery. The second return shall be gusseted in the corners to further brace the door.

Large doors (e.g. those fitted to the rear of individual switchboard/MCC tiers) shall be further stiffened with "top hat" section channels welded to the inside of the door.

Each door shall be mounted on pin type hinges and shall be secured by means of a lever operated tapered tongue catch or catches (Hinges and catches shall be Barker Nelson or equivalent). The lever shall be provided with an external stop to prevent rotation in excess of 360□ and to provide a padlocking facility. (A hole in the stop and a hole in the lever).

A minimum of two square hatch keys catches are required per door or rear panel, installed in conjunction with the tapered tongue catch at the top and bottom edges of the door on the opposite side of the hinges. For rear panels, one or both of these square hatch key catches shall be padlockable by having an extended section that encloses the latching mechanism and will allow a standard lock to prevent operation of the catch while in place.

For covers over busbar chambers, four square hatch key catches are required, with a minimum of one catch required to be lockable.

Where doors are mounted adjacent to one another the spacing shall be arranged to permit each door to open through at least 150□, without fouling the adjacent door. A stop shall be provided which shall prevent the door from opening further to obviate damage to paintwork.

Doors fitted with flush mounted equipment shall be properly braced and stiffened to support the equipment. The hinges shall be easily able to support the mass added to the door when the flush fitted equipment is installed.

The space between the back of the door and the face of the coverplate shall be nominally 80mm.

Where coverplates are provided behind the doors, the coverplates shall be adequately recessed into the cubicle to permit the spindle on the lever to drive the tapered tongue catch into a slot in the framework of the board without fouling the coverplate.

Coverplates shall be fabricated as for the doors and shall be further stiffened to compensate for the machine punches circuit breaker slots. The coverplates shall be secured at the top edge with at least two square key driven catches, whilst at the lower edge they shall be located with two 6mm diameter tapered dowel pins located in holes drilled in the architrave. Each pin shall be

[redacted]

fitted with a 1.2mm thick spacer washer. Both the pins and the washers shall be welded to the cover.

The end, rear and top coverplates shall be removable to permit access to the equipment. The coverplates shall be lockable in the closed positions.

7.1.15 Space Requirements

In arranging the chassis layouts a minimum clearance of 80mm between equipment and framework, side panels or internal divisions is required. This minimum space is required on the top, bottom and sides of equipment.

A minimum of 50 mm is required between equipment and wire trunkings. The spacing between equipment shall be sufficient to allow for the installation of conductors (taking in account the minimum permitted bending radii of conductors and cables).

A minimum of 80mm is required between power equipment (circuit breakers, contactors, etc.) and any auxiliary control devices.

7.1.16 General Mounting Requirements

No special tools shall be required to remove and re-install any equipment.

7.1.17 Switchboard Standard Colours

The following colours shall be utilised for electrical switchboards as SANS 1091

400V Mains Supply (Indoors)	EXTERNAL	B26 (Light Orange
400V Mains Supply (Indoors)	INTERNAL	G80 (Cloud White)
Emergency Supply (Indoors)	EXTERNAL	A11 (Signal Red)
Uninterruptable Power supply (Indoors)	EXTERNAL	F01 (Royal Blue)
400V Mains Supply (Outdoors)	EXTERNAL	H21 (Light Olive green)
400V Mains Supply (Outdoors)	INTERNAL	G80 (Cloud White)

7.1.18 Metering within Switchboards

A combined Maximum Demand and kWh meter shall be provided, with associated cabling, fuses, current transformer, calibration certificates etc. in the metering cubicle situated above the bus-section switch for the metering of the incomer supply from the Local Supply Authority and the incomer from the future Generator.

The meters shall be positioned behind a glass panel cut into the metering cubicle and shall only be accessible once the cubicle door has been opened. A small diameter hole shall be drilled though this glass to allow the meter function selector switch to be depressed without having to open the metering cubicle door.

This metering shall be independent of the metering to be supplied by the Local Supply Authority for billing purposes.

The meters shall be of "Power Logic ™ PM8000 series" type or equivalent. Meters nearing their end of life shall not be permitted as the City of Cape Town prefers instruments that will receive support from the manufacturers.

7.1.19 Field Control Stations

These constitute local control stations mounted adjacent to equipment such as instrumentation, motors, etc., or emergency stop stations in proximity to rotating machinery.

Where required, these field control stations shall be installed in Glass Reinforced Polyester enclosures mounted on a hot dip galvanised stand. The stand shall be constructed of a minimum of 100 mm x 50 mm U-channel, 3 mm thick, welded to at least a 300 mm x 300 mm x 3 mm thick base, bolted to the floor at each of the four corners.

[redacted]

A 3CR12 or Aluzinc hood shall be fitted over the GRP enclosure.

A proposal for such a Field Control station is shown in Drawing EAM-EE-GS-008.

7 1.20 Switchboard Construction Drawings – Standard Requirements

All Construction Drawings for switchboards (MCCs, DBs, Field Control Stations and Instrumentation Panels etc.) shall contain the following information:

a) Project Name and Contract Number
b) Manufacturer/Supplier
c) Consulting Engineer and contact person
d) Client details
e) Drawing Number and Revision
f) Colour – internal and external
g) Switchboard Dimensions
h) Base Dimensions and bolting arrangements
i) Front door details – hinge and padlock requirements
j) Rear door details – hinge and padlock requirements
k) End panel details – removable cover details
l) Door details - Stiffeners and restrainers installed etc.
m) Hinge Details
n) Locking Details
o) Handle Details
p) Cable Entry Details
q) All bolts, nuts, screws material type (i.e. 316 Stainless Steel)
r) Equipment details – CB ratings, fault levels, type, manufacturer etc.
s) Equipment Layout details – Cubicle name, function, equipment function etc.
t) Indication Light colours
u) Section to be provided through switchboard

7 1.21 Switchboard Schematic – Standard Requirements

All Schematic Drawings for switchboards (MCC's, DB's, Field Control Stations, and Instrumentation Panels etc.) shall contain the following information:

a) Project Name and Contract Number
b) Manufacturer/Supplier
c) Consulting Engineer and contact person
d) Client details
e) Drawing Number and Revision
f) Revision details to be listed
g) Drawing Page Number
h) Drawing to be Signed
i) Reference Grid required on each schematic page
j) Source of Supply – MCC or transformer name etc.
k) Fault level (kA and time rating)
l) Voltages for all circuit to be clearly indicated
m) All devices to have reference number i.e. relays
n) Equipment ratings to be given i.e. motor ratings
o) All indication lamps to be labelled including required lamp colour
p) Legend to be provided
q) Equipment Tag Numbers as per P&ID and Water Services Plant Numbering System to be provided

[redacted]

8 SWITCH-GEAR AND CONTROL EQUIPMENT FOR SWITCHBOARDS

8.1 General

All equipment shall be of sizes, ratings and specification as detailed and as shown on the Single Line Diagrams. Where feeders or cables have to be revised because of equipment selection by the Principal Mechanical Contractor, these shall be done subsequent to the award of the Tender.

All equipment shall be approved by the Engineer in writing before acceptance for use on the project, and shall bear the SANS mark.

8.2 Circuit Breakers

The circuit breakers shall comply with SANS 60947-2.

Cascading of circuit breakers is not permitted unless specified in the detailed Project Specification.

All equipment shall be of sizes, ratings, and specification as detailed in on the single line diagrams. All equipment shall be approved by the Employer in writing and shall bear the SANS mark.

Where cascading of circuit breakers is allowed, all equipment shall be coordinated and discrimination shall be taken into account.

Circuit breakers shall preferably be from the same supplier in one application.

Circuit breakers shall be equipped with an instantaneous magnetic release and a thermal release.

Circuit breakers for motor circuits shall be suitably rated.

Circuit breakers handles shall provide a clear indication of "ON", "OFF" and "TRIP" status.

Circuit breakers shall be installed vertically with the upstream terminal on top. Minimum clearances shall be maintained.

All circuit breakers shall be pad lockable in the "off" position or be supplied with means that will enable pad locking.

Circuit breakers shall be supplied and fitted with all supplementary equipment e.g. shrouds, mounting bolts, clips, adaptor plates etc.

8.3 Metal Clad Air Circuit Breakers (Acb's)

Metal clad air circuit breakers shall be of the withdrawable type and shall be suitable for use in power distribution systems up to 1000V 50Hz.

The circuit breakers shall comply with latest SANS Standard and shall have a P2 performance rating.

The ACB's shall be self-contained units of the dead front type with the necessary mechanical interlocks to prevent:-

a) Access to "Live" terminals when the circuit breaker is withdrawn.
b) The withdrawal or insertion of the ACB when the circuit breaker is in the closed position
c) Closing of the circuit breaker without resetting after an automatic trip.

The circuit breaker shall be of the quick make and quick break type with a stored-energy spring assisted operating mechanism provided with:-

a) A trip free, mechanical, hand operated closing mechanism.
b) A manually operated, mechanical, trip mechanism suitably protected to prevent inadvertent tripping.
c) A positively driven mechanical device to provide ON – OFF. - TRIP indication



All non-current carrying metal parts of the ACB shall be connected to the earthing contact on the truck of the switch, which shall engage with a mating contact on the cradle. The cradle itself shall be connected to the earthing bar in the switchboard. The contacts for the earthing shall be made in the "Racked In" position as well as in the "Test" position. The cradle shall be of robust construction and shall incorporate safety shutters.

The "RACKED IN", "TEST" and "RACKED OUT" positions shall be clearly marked and easily visible.

The ACB's shall be designed in such a way that the direction of the energy flow does not affect the operation or performance of the breaker.

Adjustable thermal overload releases shall be provided to suit the required current range. In addition, a magnetic short circuit release shall be fitted. This release shall have an adjustable current release value as well as an adjustable time lag. A minimum of four, time lag settings shall be available.

Care shall be taken to ensure the magnetic release occurs at a sufficiently low value to afford full protection under the lowest fault current conditions.(Where generators are encountered).

Each ACB shall be equipped with the following accessories:-

a) Two normally open auxiliary contacts.
a) Two normally closed auxiliary contacts.
b) One alarm contact.
c) One shunt release.
d) Padlocking facilities in the "OFF" and "TEST" positions.
e) Key interlock.

Each ACB shall allow for the fitting of the following options:-

a) Motor drive for spring charge mechanism.
b) Closing release complete with "Anti Pumping Circuit"
c) Adjustable time delayed under-voltage release.
d) Carriage switches for "RACKED IN" and "TEST" positions.
e) Mechanical interlock facility of the Bowden type.

Minimum clearances and distances between the enclosure and the arc chutes shall be strictly observed.

Full technical information of the ACB's offered, shall be supplied with the Tender.

8.4 Moulded Case Circuit Breakers (MCB'S)

Moulded case circuit breakers shall be suitable for use in 1000V distribution systems at 50Hz. The circuit breakers shall comply with SANS 556-1.

MCCB's of the same frame size and the same fault level shall be from the same manufacturer.

Circuit breakers for feeders to lighting and small power sub-distribution boards and motors shall be equipped with an instantaneous magnetic release and a thermal release.

Discrimination shall be provided in the feeder circuit breaker arrangement. An adjustable release shall be provided where deemed necessary.

MCCB's employed for motor-starting circuits shall be rated in such a manner as to avoid 'nuisance tripping'.

Feeder breakers to motor control centres shall be equipped with a thermal release and a time and value adjustable release. These MCCB's shall be selective towards the upstream and downstream circuit breakers.

MCCB's of the same frame size, where in one application an instantaneous magnetic release is employed and in another application a time lagged release is used, shall have plug–in type trip units.



The operating handles of the MCCB's shall provide a positive "ON" "TRIP" "OFF" indication of the breaker status.

MCCB's shall be installed vertically. Horizontal mounting will not be accepted.

Minimum clearances and distances between the enclosure and the arc chutes shall be strictly observed.

[redacted]

9 MOTOR STARTING AND DRIVE SYSTEMS

9.1 General

Motor starter and in general all starter panels shall be as per drawing No.EAM-EE-GS-030.

Direct-on-line motor starter contactors shall be equipped with three pole thermal overload relays according to the rating of the motor. This shall be a combination unit with the door-interlocked circuit breaker.

The thermal overload relay shall be provided for single-phase protection, it shall be equipped with an electrical/electronic reset facility, see overload relays on section 13.12.

Drives to high gear ratio motor (such as the screen drive, screw conveyor and compactor) shall be equipped with an electronic shear-pin device. This protection relay will disregard the motor starting current, but trip the drive, should the current rise above a set threshold during running.

Should a phase failure or imbalance relay be incorporated in the design, this trip mechanism shall be manually reset along with the thermal overload relay.

9.2 DOL Motor Starter Compartments

Motor starter compartment shall include for a minimum of:-

a) Circuit-breaker (back plate mounted and arranged vertically).
b) Mechanical operating handle for circuit-breaker, including door interlock, self-aligning spindle and padlocking facility (door mounted).
c) Current transformer class 1,5 (backplate mounted).
d) Ammeter.
e) Run Hour meter.
f) Contactors for DOL starting or contactors for alternative methods of starting (backplate mounted).
g) Thermal overload device operating on single phase / three phases (usually mounted on contactor).
h) Electrical/electronic reset push button for thermal overload (via door mounted pushbutton
i) Selector switches MAN, OFF, AUTO (door mounted).
j) Stop / emergency stop push buttons (door mounted).
k) Start push button (door mounted).
l) Relays for stop: start and other controls where required (back plate mounted).
m) Pilot lights for:
m) (i) motor stopped but power available (red)
m) (ii) motor running (green)
m) (iii) motor tripped (amber)
n) Din rail mounted terminals.
o) Lamp Test (black push button)
p) Submersible motor application

9.3 VARIABLE FREQUENCY CONVERTORS

9.3.1 General

The Varispeed/WEG, DELTA, Allen Bradley, ABB 400kW or equivalent to approval variable frequency drives (motor starter/controller) shall be capable of driving a motor to its full, rated, nameplate output, at frequencies as specified, for an indefinite period. Short time ratings may not be considered.

(a) Technical requirements for variable frequency drive

The variable frequency drive shall be designed to the following technical requirements:

Item	Description
Type	The drive shall be of the dc link pulse width modulated type and shall be fully digital, to the approval of the Engineer. The VFD shall include line chokes for

	filtering line harmonics to 2% or THD or less and shall be supplied by the same manufacturer of the VFD. Line chokes that are not from the same VFD manufacturer will not be accepted.
Operation	Speed control through frequency variation with minimal losses. The desired operating speed shall be a measure of the frequency set point.
Line frequency	50 Hz ± 2,5 %
Power switching	Power switching elements shall be Insulated Gate Bi-polar transistors.
Efficiency	Shall exceed 96 %.
Overload factor	120 % for 50 s
Load side voltage	400 V
Operation Status Indication	A standard VSD keypad operator HMI indicator shall be provided and mounted on the VSD door or behind a suitable window in the door. In addition to the above keypad display functions, the following shall be provided and mounted on the VSD panel door and shall be open to view on the keypad operator. Motor running indicator lamp (LED) (Green) Motor stopped indicator lamp (LED) (Red) Fault indicating lamp (LED) (Amber) Starter healthy indicating lamp (LED) (Red)

(b) Selection functions and facilities of variable frequency drive

The selection of functions and the setting of parameters shall be accomplished through the use of menu driven software and a control pad. The control pad shall be a membrane covered keypad with LED display unit and shall be mounted on the front door of the enclosure and cabled to the drive. The control pad shall be lockable and shall not be available to the operator for normal operations. The LED display shall, however, be visible.

The drive shall be capable of providing the following minimum control functions:

Item	Requirement
Skip frequencies	A minimum of three programmable skip frequency ranges
Auto restarts	A programmable number of restarts with a programmable delay.
Ramp functions	Individually programmable start up and slow down ramp functions.
Ramp functions	Individually programmable start up and slow down ramp functions
Running hour meter:	The variable speed controller shall give the total running time for the connected motor.
Communication interface:	RS 485 (capable of communicating over a 10 m length of cable)
Analog control inputs:	Remote speed reference (0-10 V).
Local speed	Thermistor (motor) (0-10 V).
Digital control inputs	External trip, Local start/stop, Auto; Off; Manual switch, Fault, Reset
Control outputs:	Fault relay Run relay Low speed relay Motor current (0-20 mA and/or 0-10 V) Motor frequency (0-20 mA and/or 0-10 V)

[redacted]

Protection:	Thermal Current limit Instantaneous over current trip Individual drive protection Earth fault detection Phase imbalance detection or loss of output phase or phases.
Frequency:	Adjustable in the range 2 000 Hz to 5 000 Hz.
Range of Speed Adjustment:	0 - 70 Hz
Start/Emergency stop:	Start/Emergency stop push buttons shall be mounted on the front door of the respective enclosure and wired accordingly.
Auto, Off, Manual:	An auto, off, manual switch shall be provided on the front door of the cubicle and wired accordingly.
Manual Speed Control:	A potentiometer shall be provided inside the enclosure.

The variable frequency drive shall incorporate simple controls for adjusting the ramp-up time and regulating the starting current.

The Contractor shall wire the following variable frequency drive status signals back to the Telemetering cubicle:

a) Motor running / motor stopped
b) Motor trip O/L
c) Running Current

9.3.2 Technical Requirements for variable frequency drive

The variable frequency drive shall be designed to the following technical requirements:

Item	Requirement
Type	The controller shall be of the dc link pulse width modulated type and shall be fully digital, to the approval of the Engineer.
Operation	Speed control through frequency variation with minimal losses. The desired operating speed shall be a measure of the frequency set point. Constant flux shall be supplied over the entire speed range. The inverter shall be the final controlling element for the drive voltage and frequency, in accordance with pre-set selections. The modulated output voltage shall ensure smooth running of the motor with minimal losses and noise down to the minimum speed.
Line frequency	50 Hz ± 2,5 %
Power switching	Power switching elements shall be Insulated Gate Bi-polar transistors.
Efficiency	Shall exceed 96 %.
Overload factor	120 % for 50 s
Load side voltage	400 V
Indication	The following indication shall be provided and mounted on the door or behind a suitable window in the door: Ammeter (measuring motor current) Motor Speed (in r/min) Running Hour meter (motor running hours) Motor running indicator lamp (LED) (Green) Fault indicating lamp (LED) (Amber) Starter healthy indicating lamp (LED) (Red)

9.3.3 Control Functions and Facilities

The drive shall be capable of providing the following minimum control functions:

Analog control inputs:

[redacted]

Item	Requirement
Local speed reference	(0-10 V).
Remote speed reference	(0-10 V).
Thermistor (motor)	(0-10 V).
Skip frequencies	A minimum of three programmable skip frequency ranges.
Auto restarts	A programmable number of restarts with a programmable delay.
Ramp functions	Individually programmable start up and slow down ramp functions.
Running hour meter	The variable speed controller shall give the total running time for the connected motor.
Communication interface	RS 485 (capable of communicating over a 10 m length of cable)
Digital control inputs: Local start/stop, remote start/stop, Auto;Off;Manual switch	External trips
Fault	External trips
Reset.	External trips
Control outputs:	Fault relay Run relay Low speed relay Motor current (**0-20 mA** and/or **0-10 V**) Motor frequency (**0-20 mA** and/or **0-10 V**)
Protection:	Thermal Current limit Instantaneous over current trip Individual drive protection Earth fault detection Phase imbalance detection or loss of output phase or phases.
Switching Frequency: Range of Speed	Adjustable in the range **2 000 Hz** to **5 000 Hz**.
Adjustment:	0 - 70 Hz
Start/Stop:	Start/Stop push buttons shall be mounted on the front door of the respective enclosure and wired accordingly.
Auto, Off, Manual:	An auto, off, manual switch shall be provided on the front door of the cubicle and wired accordingly.
Manual Speed Control:	A potentiometer shall be provided inside the enclosure.

The variable frequency drive shall incorporate simple controls for adjusting the ramp-up time and regulating the starting current.

9.4 ACTUATED VALVE STARTER CUBICLES

The following equipment mounted behind the front door of the cubicle:-

a) Moulded case circuit-breaker [for motor applications] (cradle mounted and arranged vertically behind the door at the second architrave level).

b) Mechanical operating handle for circuit-breaker, including door interlock, self-aligning spindle and padlocking facility (door mounted).

c) Hour meter

d) Electronic reset push button for overload (door mounted).

e) Selector switch MAN, OFF, AUTO (door mounted)

f) Door mounted pilot lights for:-

f) (i) motor stopped but power available (red) - motor running (green)

f) (ii) Motor tripped (amber).

f) (iii) Siemens Logo Controller (or equivalent)

f) (iv) Din rail mounted terminals.

f) (v) Lamp Test (black push button)

f) (vi) Key Switch, back-plane mounted, to enable/disable actuated valve controls (i.e. actuated valve controls must be in the "enable" position in order to control the actuated valve from the cubicle door)

10 WIRING, CABLE TERMINATIONS AND GLANDING

All wiring within panels may be enclosed in PVC slotted ducting. The exception is signal and instrumentation cabling passing through power compartments or cubicles, which shall be in galvanised screwed conduit. Wiring outside of panels and switchboards shall be run within galvanised ducting or conduit.

All wiring and terminations shall be labelled with identification tags corresponding to the wiring diagrams. Cable terminations shall be marked with an identification label externally to the switchboard indicating the source of supply as well as the equipment being fed for feeder cables or example: "FED FROM MCC 1" and "SUPPLY TO SUMP PUMP".

11 STANDARD COLOURS – INDICATION LAMPS AND BUTTONS

The suitability of colours employed is generally based on IEC 60073 (No SANS version/ to be updated with latest Standard).

Due to colour schemes on existing plant and user/operator familiarity, the application of certain colours differs from IEC 60073 (To be updated with latest standard). For clarification, the lamp colours are a reflection of the status of the particular control system (front of panel towards equipment to be controlled).

The following colours shall in general be employed on switchboards for indication lamps, push buttons and selector switches:

COLOUR	Condition / Meaning / Application
Red	System stopped/not running or CLOSED
Amber/yellow/orange	Any warning/trip/abnormal condition
Green	System running/healthy/normal/ SAFE Condition or OPEN
Blue	Step/Process change condition
White	Mode indication or other indication (where doubt exists about applicability of Red, Yellow or Green)

Specifically, the application of colours shall be as follows:

INDICATION LAMP COLOURS	TYPE	COLOUR	Examples/Specifics
Local/Auto/SCADA Mode	Indication Lamp	WHITE	
Bus Bar Alive	Indication Lamp	WHITE	
Capacitor Bank Discharged	Indication Lamp	GREEN	Power Factor Equipment
Closed	Indication Lamp	RED	Valves, penstocks
Differential Pressure – HIGH	Indication Lamp	AMBER	
Differential Pressure – NORMAL	Indication Lamp	GREEN	
Earth Fault	Indication Lamp	AMBER	MV Equipment
Emergency Stop	Indication Lamp	AMBER	
Mechanical Seal Failure Warning	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture in Coolant	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture/Water Ingress	Indication Lamp	AMBER	
Motor Winding Over Temperature	Indication Lamp	AMBER	May be flashing AMBER



Open	Indication Lamp	GREEN	Valves
Overload	Indication Lamp	AMBER	
PFC Fault	Indication Lamp	AMBER	Power Factor Equipment
Running	Indication Lamp	GREEN	
Starter Alive (Circuit Healthy)	Indication Lamp	GREEN	
Stepped Function	Indication Lamp	BLUE	Power Factor Equipment
Stopped & Power Available	Indication Lamp	RED	
Tripped	Indication Lamp	AMBER	

PUSH BUTTON/SELECTOR SWITCH COLOURS			Examples/Specifics
Emergency Stop	Push Button	RED	With yellow backing
Lamp Test	Push Button	BLACK	
Reset	Push Button	BLUE	
Start	Push Button	GREEN	
Stop	Push Button	RED	
Up/Down/Left/Right/Forward/Reverse	Push Button	BLACK on WHITE	
Selector Switches/Knobs		BLACK	with Black back plates with white lettering

Note: AMBER=YELLOW=ORANGE

For All new equipment installed shall match the existing plant equipment (lamp/pushbutton etc.) All indication lamps to be accompanied with engraved backing plates.

The Engineer shall provide the final confirmation/approval of ALL colours to be employed on existing or new plant.

[redacted]

12 SWITCHBOARD ACCESSORIES

12.1 GENERAL

Refer to the switchboard equipment schedule in the Project Specification as well as the proposed Motor Control Centre layout drawing in the Project Specification for additional details. All manufacturers / suppliers of switchboard accessories shall ensure that the equipment is SANS certified. All systems providing starting and control shall provide full protection from the effects of internal and external faults.

12.2 INSTRUMENTATION IN GENERAL

Instruments shall generally be designed for an accuracy of 1% (Class 1) of the full-scale reading. (Assume the frequency remains constant at 50 Hz). Instrument faces shall be either 96mm x 96mm on large panels or 76mm x 76mm on smaller panels. The faceplates shall be painted white with black paint for the lettering and scale divisions. A thumbnail operated adjuster shall be provided to zero the pointer at any given time. A clear glass window that is positively located by the framework of the instrument shall enclose the pointer and faceplate. The glass shall be mounted on a gasket that will seal the space between the faceplate and the inside surface of the glass against the ingress of moisture and dust. Terminals shall comprise nuts on a moulded in stud at the rear of the instrument. The terminals shall be fitted with two washers and a colour coded rubber shroud. The shroud shall allow the wire, fitted with a lug, to approach the stud at 900 and shall be moulded accordingly.

Instruments shall be provided with a scale not less than 20% above the normal operating value of the function being measured, then rounded up to the nearest standard scale provided by the manufacturers.

12.3 VOLTMETERS

Volt meters shall be of two sizes 96mm x 96mm on the large panels and 72mm x 72mm on the smaller panels. The meters shall be of the moving iron type and the movements shall be mounted on shockproof suspensions. The accuracy shall meet class 1.5 i.e. 1,5% of full scale value at each reading.

The main incoming section of the Switchboards (Motor Control Centres in particular) shall have a Voltmeter of 96 mm x 96 mm size, equipped with coloured surrounds representing each phase, i.e. Red, White and Blue and equipped with a phase selector switch. The switch shall permit the indication of all phase to phase and phase to neutral voltages on the voltmeter. The phases shall be noted as "R", "W" and "B".

Where a voltmeter is connected to the main busbar and a selector switch is provided for the operator to monitor the voltage between any two phases or between any phase and neutral, then two sets of HRC fuses shall be provided. One set mounted on the respective phase bars and the second set mounted adjacent to the voltmeter on the back of the door. The fuses mounted on the cover plate shall each be provided with an element that affords protection for the conductors run between the two sets of fuses. The second set of fuses shall be fitted with elements that afford protection for the selector switch and instrument, besides being a convenient (and safer) point of disconnection for the maintenance staff. The minimum wire size for a voltmeter circuit shall be 2,5mm^2.

12.4 AMMETERS

Digital Indicators

Indicators shall conform to the following:-

a) Digital with relay outputs
b) Microprocessor based
c) LED display
d) Measurements 96mm x 48m Unit must be pluggable Inputs:
d) (i) ACV
d) (ii) DCV

[redacted]

d) (iii) Pt100
e) Process signals:
e) (i) At least 2 relays
e) (ii) Isolated retransmit
e) (iii) Current limiting for power and retransmit signals
e) (iv) Programmable from front panel

Basic specifications:-

Item	Requirement
Power Supply	115V 50/60Hz 230V 50/60Hz 24V 50/60Hz 24VDC Isolated
Power consumption	3~6VA
Display reading	User programmable from -999 to +999
Input	Thermocouple J,K,N,R,S,T, Pt100 0/4~20mA, 0/1~5V 0/2~10V, 0~1mA AC Volts true RMS AC Amps true RMS
Accuracy	±0,25% of span ± 1 digit
Repeatability	±0,2% of span ± 1 digit
Operating temperature	-5 to +65°C
Operating Humidity	0 to 95% RH Non Condensing
Relays-SPDT	AC 5A 250V 1250VA DC 5A 30VDC

Ammeters shall be of two sizes 96mm x 96mm on the large panels and 72mm x 72mm on the smaller panels. The meters shall be of the moving iron type and the movements shall be mounted on shockproof suspensions. The accuracy shall meet class 1.5 i.e. 1,5% of full scale value at each reading.

The main incoming section of the Switchboards (Motor Control Centres in particular) shall be equipped with instantaneous and maximum demand ammeters of 96 mm x 96 mm size, equipped with coloured surrounds representing each phase, i.e. Red, White and Blue.

Each individual starter/drive cubicle shall be equipped with a 76 mm x 76 mm logarithmic scale instantaneous ammeter, with a label above the ammeter indicating the full load current for the respective drive.

Ammeters for ac applications shall be of the type suited to motor drives and shall provide a substantive over-range to allow for the motor starting current. The faceplate shall be marked, with a red line, at the point on the scale where the absorbed motor current occurs. Ammeters shall be arranged in circuit for direct reading or indirect reading (CT operated), as required. Direct reading devices shall be employed up to a maximum of 40 A. Where multiple CT's are installed to permit a single instrument to indicate the load on each phase, in sequence, a rotary selector switch shall be provided which will permit the operator to select the phase he wishes to monitor. The CT's shall be connected in a star configuration and the star point shall be directly connected to the main earthing bar in the MCC. The minimum wire size for a CT and Ammeter circuit shall be 2,5mm².

12.5 RUN-HOUR METER (RHM)

Run-hour meters in general shall be 72mm x 72mm in size and shall be installed for all motor starting and controlling applications. Run-hour meters shall be mounted on access doors with the face of the meter visible from the front of the board.

Run-hour meters shall be suitable for 230V 50Hz applications and arranged to operate directly from the control voltage but shall be controlled by the motor starter. The dial shall be cyclic and shall count to 99999,9 before returning to 0. A reset facility is not required.

Run-Hour meters shall however be the same physical size as the Ammeter on the same panel. Enlarged bezels that make the run-hour meter appear the same size as the Ammeter, will not be accepted.

12.6 **TIME SWITCHES**

The time switches shall be of the 24 hour type, operating on a 230 V 50 Hz supply with an electrically wound 9 hour spring reserve. The time switches shall be mounted behind the hinged access doors. Each time switch shall be fitted with fifteen "on" stops and fifteen "off" stops thereby providing 30 selective operations per 24 hours.

12.7 **TIMERS**

The timers shall be of the electronic plug-in type operating on a 230 V 50 Hz supply. The timers shall be adjustable by turning a knob. They shall be mounted facing the front of the board but behind the access door.

12.8 **FUSES**

The fuses shall comply with SANS 60269-1 and SANS60269-4 and shall be adequately rated for the circuit currents. All fuses shall be positioned so as to be accessible.

12.9 **FUSE HOLDERS**

All fuse holders shall comply with the latest SANS Standards and shall be adequately rated to cater for the load currents.

12.10 **SELECTOR SWITCHES**

Selector switches shall be of the rotary pattern and shall be mounted on the cubicle doors or on the door to the panel above the circuit breaker. All selector switches shall have a minimum rating of 15 A.

These shall preferably be of the same manufacturer as the push buttons and indicators lamps.

Selector switches shall allow contacts arranged in wafer housings that permit stacking along, and positioning about, the centrally mounted spindle driven by the operating knob. The escutcheon plate mounted on the door of the motor drive, or other, cubicle shall be secured with screws secreted from view by the 'snap on' plastic cover which shall be engraved in accordance with the circuit requirements (i.e. ON - OFF. REMOTE - OFF - LOCAL. MANUAL - OFF - AUTOMATIC) etc. The spindle shall be splined to allow the contacts within the wafer housings to be 'timed' for early or late, make and brake contacts, as required.

12.11 **RELAYS**

The relays shall be general purpose plug-in relays with octal or 11 pin bases. Soldered connections to bases will not be accepted. Each relay shall be tightly sealed with a clear plastic cover. All relays shall operate on a 230 V 50 Hz supply.

12.12 **OVERLOAD RELAYS**

The overload relays shall be of electronic thermal overload protection with integrated "locked rotor" protection, or thermal type with an element in each phase and shall conform to the characteristic curve held by the manufacturer with a tolerance of + 10% of the values as specified in the SANS/IEC 60947-4-1.

12.13 **CONTACTORS**

The contactors shall be operated electro-magnetically. The control voltage shall be 230 V, except for the dc emergency lighting contactor, which shall be 110 V dc. Contacts shall be capable of



carrying 125% of the full load circuit current continuously. The contactors shall be suitable for "Intermittent Duty" 15 operations per hour.

12.14 **CONTROL PUSHBUTTONS**

In conjunction with the Clause entitled "STANDARD COLOURS – INDICATION LAMPS AND BUTTONS", the Control Pushbuttons shall be of the round, flush, spring-loaded type, 22,5 mm in diameter, coloured in accordance with the duty as follows:-

START	Green
STOP	Red
LAMP TEST	Black
RESET	Blue

For field mounting of Control Pushbuttons, these shall be mounted and positioned as indicated on drawing No.EAM-EE-GS-008 depicting a general arrangement of a Field Control station.

12.15 **INDICATING LAMPS**

Indicating lamps shall comprise a cluster of four light emitting diodes arranged in a common housing. Each lens shall be coloured as required for stop, start, alarm, trip, etc. shall be at least 20 mm diameter and shall be clearly visible through an angle of 1800 in a brightly lit room (500 - 600 Lux) and the contrast between an energized condition and a de-energized conditions shall be clearly visible from all sides as well as in front.

The indicators shall be suitable for use on either 230V AC / 24V DC supply as per project specification. If the LED is not able to operate direct from the control voltage called for then a separate controller shall be provided with each LED to ensure that all LED's are fully interchangeable with those adjacent or on a separate panel some distance away.

The housing shall be fitted through a hole in the door of the cubicle and shall be secured with a separate screwed ring or a bayonet plate that is tightened into position with grub screws. The housing body shall be provided with a key to locate in a groove in the door cut-out to prevent the housing from rotating.

In conjunction with the Clause entitled "STANDARD COLOURS – INDICATION LAMPS AND BUTTONS", the lens shall be coloured in accordance with the duty as follows:-

Red	System stopped and power available.
Green	System running.
Amber	System tripped.
Amber	Water ingress detected (Submersible / Immersible machines).
White	Busbar alive.

12.16 **STOP PUSHBUTTONS**

Stop push buttons shall comprise two main components namely a front mounted operator and a rear mounted contact block. The front mounted operator shall be fitted with a cylindrical housing, which is attached and keyed to the mounting panel. The cylindrical component shall house a spring returned, flush mounted button. The rear mounted contact block shall be arranged with a bayonet feature that attaches to the front mounted component and is secured with grub screws or a locking ring. The push button shall actuate a silver alloy bar contact rated at not less than 15A. Conductors shall be fitted with a crimping ferrule to be secured by a screw adjusted clamping terminal mounted in the contact block. The complete assembly when mounted and

[redacted]

connected shall provide protection against the ingress of dust or vapours to IP66. Once access is gained to the rear of the device the Technician shall still be protected from accidental contact to IP4x. The unit shall be maintenance free and shall provide at least 1 million operations before failure. The front mounted operator shall be coloured RED and shall be engraved with the word STOP. The contact block shall be provided with locators and screw anchors or clips, to accommodate an additional contact block mounted "piggy back" on the first contact block.

12.17 **START PUSHBUTTONS**

Start push buttons shall be arranged as for stop push buttons with the exceptions that the contacts in the contact block shall be normally open and the front mounted operator shall be coloured GREEN and engraved with the word START.

12.18 **RESET PUSHBUTTONS**

Where required, reset push buttons shall be spring loaded mechanical devices, mounted immediately in front of the electrical overload. The outer appearance of the housing for the reset push button shall be similar to the start or stop push buttons on the same panel. The rod attached to the push button shall be adjustable to suit the depth of the drive cubicle, as required. The push button housing shall be of sufficient depth to provide proper support for the extension rod. The front mounted operator shall be coloured BLACK and engraved with the word RESET. To achieve a pleasing layout of equipment on the door to the motor drive cubicle it may be necessary to adjust the position of the overload device within the cubicle.

12.19 **EMERGENCY STOP PUSHBUTTONS**

Emergency stop push buttons shall be arranged in similar fashion to the stop buttons. The operating pushbutton however shall be at least 50mm in diameter and shall be knurled at the periphery. The mushroom head shall be mechanically latched when it is pressed, to prevent the contacts, within the contact block, from re-closing. To release the mechanical latch, and thus close the contacts, the operator shall be required to rotate the push button head through at least 600.

12.20 **NAME PLATES AND LABELS**

Each component of electrical apparatus installed under this Contract shall be properly and unambiguously labelled. Components on/in a distribution board shall be individually labelled, the compartments in which these components are mounted shall be labelled as an entity. The labels on the outside of each compartment shall be operator orientated, whilst the labels inside the various compartments shall be technician orientated and shall be worded/numbered as per the wiring diagram for the respective cubicle/compartment.

All labels shall be secured to the outside and inside of distribution boards with machine screws. Self-threading screws or glue will not be permitted. The exception is equipment labels within the switchboard, which may be glued only. All screw fixed labels shall be jig drilled to provide interchange ability between compartments.

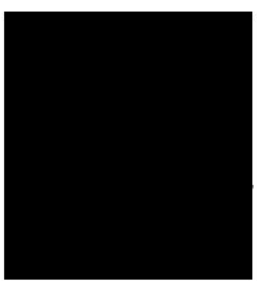
All notices and labels for warning purposes or indicating dangerous conditions shall be in English, Afrikaans and IsiXhosa. General operating and identification notices and labels shall be in English only. Labels shall have black letters on a white background for standard labels or white letters on a red background for caution, warning or danger labels.

Each label shall comprise a high quality plastic tri-laminate and the wording shall be engraved through the outer layer to expose the colour of the centre layer. All engraving shall have sharp, clearly defined edges.

Labels and character sizes shall be commensurate with the size of article being labelled, with the proviso that where a range of label sizes would thus occur on a panel, the labels/character sizes shall be of a uniform average size.

12.21 **LABELING OF DISTRIBUTION BOARD**

The source of supply need to be indicated for Circuit breakers.



Circuit breakers shall be numbered with suitable engraved two layer "Trefolite", black lettering on white. The labels shall slide into an aluminium bracket as per attached drawing. Each circuit breaker shall have a unique number and the number shall not be repeated on the same board. However the numbering on each board shall start at 1. Multi-phase breakers shall have a number for each pole.

Boards shall be numbered in "levels" e.g. the boards supplied by the transformer, mini substation or municipal kiosk shall be numbered MAIN DB1, MAIN DB2, etc. The sub boards supplied by these boards shall be numbered SUB DB1.1, SUB DB1.2, SUB DB2.1, etc.

The numbers shall be repeated on a legend card that is displayed on the inside of the board. The card shall indicate the following:

a) Circuit breaker number
b) Type of circuit e.g. power points, lights, etc.
c) Rooms numbers supplied
d) Number of lights, power points, etc. in brackets

The proposed numbering shall be submitted to the Employer for approval prior to manufacturing of the labels. Labels that are manufactured incorrectly shall be for the contractor account.

12.22 SUB-DISTRIBUTION BOARDS

A separate earth continuity conductor shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard. The earth continuity conductor shall consist of insulated stranded copper conductor installed along the same routes as the supply cables or in the same conduit as the supply conductors.

12.23 Distribution board layout tracing and labelling.

Refer to Drawing: list of drawings in Annexure A in this specification.

13 EARTHING AND LIGHTNING PROTECTION

13.1 EARTHING

The earthing installation shall comply with the requirements of the latest revision of the Wiring Code of Practice (SANS 10142-1) as well as the requirements of the Local Supply Authority.

Earthing shall be undertaken as detailed on in the Project Specification.

The Neutral shall not be bonded to the Earth in the Motor Control Centre, but at the source of supply, namely the transformer.

All metallic cable support systems, handrails, ladders and access platforms shall be connected to the earthing system.

The resistance measured between the consumers earth terminal and any exposed conductive part of the installation or any other conductive part that needs to be bonded to the earth continuity conductor shall not be more than 0,2 ohms.

13.2 LIGHTNING PROTECTION

Lightning protection for this installation shall be limited to surge arrestors on the main board and suitable voltage protection on the instrumentation cables and equipment.

The surge arrestors shall be of an approval manufacture and shall bear the SANS mark of approval.



14 CABLE TRAYS

14.1 GENERAL

All proposed cable tray installations shall be neatly sketched and submitted to the Engineer for approval before any cable tray work is commenced. The sketch shall include principal dimensions and show the proposed cable tray routes.

Cable trays shall be wide enough to accommodate the cables required in terms of this contract plus 15% spare capacity for future additions.

14.2 MATERIAL AND MANUFACTURE

Cable tray shall be of the heavy-duty type manufactured from 2,0mm thick sheet steel and hot dipped galvanised after manufacture, designed for internal and external use.

Cable trays shall be plumb and true to line and shall be arranged either vertically or horizontally. Trays fixed to brickwork or concrete shall be mounted on 90° Z section spacer brackets, manufactured from 3 mm thick material, to space the back of the tray 30 mm from the structure. The brackets shall be full tray width and shall be provided along the cable tray route at approximately 500mm centres. Brackets shall be provided where cable trays terminate.

Each bracket shall be fixed to the wall with two 8mm anchor bolts entered at least 70mm into the wall whilst the tray shall be secured to each bracket with two 6mm galvanised steel set screws with nuts and washers.

A sample of the spacer brackets shall be submitted to the Engineer for approval, before proceeding with the manufacture of the remaining brackets.

Joints in the tray shall be kept to a minimum and shall only occur coincident with a spacer bracket position or cross brace position.

Bends and tees in the cable tray shall be factory made by the same manufacturer as the cable tray. Joints in the cable tray shall be kept to a minimum and shall be arranged to occur coincident with a support bracket.

Nylon washers may be employed to prevent galvanic reaction between galvanised steel and 3CR12 or Aluzinc or 316 steel (for specialised installation), but careful consideration shall be given to ensure earthing continuity of all metallic items employed.

Should the environment be considered corrosive (for example Wastewater Treatment Plants or near the coast) the Engineer may call for all brackets, straps, cable tray, bolts, nuts, washers, etc. employed for the cable tray system to be manufactured from AISI 316 stainless steel.

14.3 CABLE POSITIONING AND FASTENING

All cables shall be neatly fastened to the tray with PVC cable straps at 300mm centres.

Where cable trays are run Vertically, Power Cables shall be installed at the bottom of the cable tray and instrumentation and signal cables at the top.

Where cable trays are run horizontally, Power Cables shall be installed closest to the supporting surface i.e. wall, and instrumentation cable to the front.

All cables shall be run and cleated in accordance with the wiring regulations and shall be run in the ground or on cable trays secured to concrete, brick or steel structures.

[redacted]

15 BUILDING SERVICES INSTALLATION

15.1 GENERAL

All equipment supplied shall be suitably rated to the identified fault level in the Project Specification.

All electrical components supplied and installed, shall bare labels indicating its supply source. These labels will be secured to the outside and or inside of each electrical component with machine screws. Self-threading screws or glue will not be permitted. All screw fixed labels shall be jig drilled to provide interchangeability between compartments.

15.2 LIGHTING FITTINGS

The preferred lighting fittings for use in installations are as follows:

Type Description

Item	Requirement
A	341mm x 195mm diameter surface mounted bulkhead lighting fitting with silver die-cast aluminium alloy body and diffuser, stainless steel securing screws, clear prismatic diffuser, ballast and holder to accommodate one 26 W lamp to BEKA Cat. No. 31126 or equivalent, complete with Osram lamp.
B	1 512 mm x 172 mm, 54 W two lamp totally enclosed, corrosion, dust and vapour proof surface mounting fluorescent lighting fitting with one piece injection moulded, clear UV stabilised, polycarbonate diffuser with anti-tamper clips, To BEKA Cat. No. VLN – 254/ECG54 or equivalent, complete with Osram T5 lamps.
C	1 512 mm x 172 mm, 54 W one lamp totally enclosed, corrosion, dust and vapour proof surface mounting fluorescent lighting fitting with one piece injection moulded, clear UV stabilised, polycarbonate diffuser with anti-tamper clips, complete with lamp. To "BEKA Cat to. VLN 254/ECG or equivalent, complete with Osram T5 lamps.
D	High Bay lighting fitting, complete with encapsulated ballast. To BEKA Cat. No. BEKAWAY – 150W HPS or equivalent, complete with Osram lamp
E	High Bay lighting fitting complete with hot dipped mounting bracket. To. Beka Cat. No. MAX-F or equivalent, complete with Osram HPS lamp

15.3 LIGHTING SWITCHES

The preferred switches for use in installation are as follows:

Type Description

Item	Requirement
A	16 A – One lever one way rocker type flush mounted switch, with 100% polycarbonate construction, modular design, removable clip on surround which covers the fixing screws and plates complete with standard fixing screws. To Lumex Series 2000 Code S2031/1/2AWE, or equivalent. Colour Black.
B	16 A – One lever two way rocker type flush mounted switch, with 100% polycarbonate construction, modular design, removable clip on surround which covers the fixing screws and plates complete with standard fixing screws. To Lumex Series 2000 Code ST2031/2/3AWE-ST2031IWE, or equivalent. Colour Black.

15.3.1 Lighting Switches General

15.3.2 Non-Uniform Wall Finishes

Switches located on walls near change of wall finish, e.g. on tiled, face brick, or wood panelled dadoes, and must be arranged so that the cover plates fall completely within one or other of the surfaces and not on the junction line of the different finishes. The Contractor must collaborate with the Principal Contractor and other trades to ensure that switches on such surfaces present a neat appearance.

[redacted]

15.3.3 Lighting Switches in Demountable Partitions or Mullions

Where these are specified they must be of the special narrow type, nominally 25mm wide and mounted flush in vertical hollow mullions or similar hollow metal clad partition members. The opening in the mullions and the holes for reception of the switch-cradle and its fixing screws must be provided by the Contractor. The Contractor must provide the fixing screws, which may be self-tapping and provide and fit an overlapping cover plate, finish as specified, to match the special narrow switch.

15.3.4 Lighting Wiring to Switches in Hollow Mullions and Demountable Partitions

The wiring to these switches may be run within the hollow mullion or other hollow metal structural members of the partitioning, but must be run in conduit from the lighting outlet, terminating with a bush at the point where wiring enters the hollow mullion. Where the wiring for lighting circuits is run in a ceiling channel which is situated directly over the hollow mullion or other wire carrying member, then the wiring to switches may be taken directly into the latter without the use of conduit or lead in tubes. Under no circumstances must the wire pass over sharp edges and suitable provision must be made to shield the wiring accordingly.

15.3.5 Lighting Wiring of Lighting Circuits

Lighting circuits shall be wired with not less than 1.5mm² conductors. Lighting circuits shall be adequately rated to accommodate inrush currents.

15.3.6 Lighting Photo Cells

Photo Cells shall be mounted external to a building and at least at the same height of the luminaires it controls. Care shall be taken that the light spill from the controlled luminaires or any other luminaire does not affect the photo cell adversely. Fitting of light reflecting covers will not be permitted.

A rotary type switch mounted within the distribution board, shall be wired in the control circuit, to bypass the photo electric light sensing cell for testing purposes. A single pole circuit breaker shall be provided for the control circuit and connected to the load side of the triple control circuit breaker protecting the contactor.

15.3.7 Lighting Dimmers

Dimmers shall be as rated and selected to suit the application.

15.3.8 Lighting Low Voltage Transformers

Low voltage transformers shall be WACO Code: V1P/TRAY-ET60, Voltage: 240V / 50Hz, Rated current (Primary): 0.26A, Secondary voltage (V): 11.65V Max 5.3A AC, Rated load (W): 20W - 50W, Short circuit protection -Auto reset on start, Thermal protection - Single shot, Surge protection: 1 KVP, Input terminal: 2.5mm, Output terminal: 2.5mm, Dimmable - To be used with a trailing edge dimmer only, Length: 125mm, Width: 35mm, Height: 30mm, Class: II, IP: 20 or similar and approved.

15.3.9 Lighting Isolators

Flush mounted isolators shall be installed for all domestic applications i.e. stoves, hot water cylinders, boiling water installations, etc.

Industrial pad lockable isolators shall be installed for air conditioning units, gate motors, extractor fans, etc. Isolators shall be IP65 rated.

15.4 SWITCHED SOCKET OUTLETS

The preferred power outlets for use in installation are as follows:

Type Description



Item	Requirement
A	16 Ampere, double, switched socket outlet, on yoke, to fit 100 mm x 100 mm wall box, with cover plate. To Lumex Series 2000 Code ST2025WE, or equivalent and approved. Colour Black.
B	3 phase neutral and earth, switched socket outlet, 32 A. To Clipsal Code 76252-6 complete with plug, or equivalent and approved. Colour Black.

15.4.1 Switched Socket Outlets General

All power socket outlets shall conform to the types set out in the Project Specification Annexures or Single Line Diagrams.

All power socket outlets shall be at a height of 500mm above finished floor level, or as otherwise specified in Project Specification or on Drawings.

Where the socket outlet position would interfere with dado lines or other finishes the final position shall be decided on site by the Engineer.

15.4.2 Surface Mounted Switched Socket Outlets

Where conduit or cable is surface run or where specified, switched sockets of the surface mounted metal clad type must be used.

15.4.3 Waterproof Switched Socket Outlets

Switched socket outlets installed in positions or situations exposed to the atmosphere or damp surroundings or where specified, supplied shall have an IP65 rating.

15.4.4 Industrial Switched Socket Outlets

Industrial switched socket outlets shall be five pin type as specified, with mechanical interlock and pad lock facility. Sockets shall be rated IP65.

15.4.5 Mounting Heights

Where no other mounting heights are indicated in the Scope of Works, switched socket outlets will mounted at the following heights from finished floor level to the bottom of box:

Flush switched sockets, Offices	500mm
Workshops, Garages, Kitchens	1300mm

15.5 SWITCHED SOCKET OUTLETS CIRCUITS

15.5.1 Single phase socket outlet circuits

Circuits to single phase power socket outlets shall comprise two conductors not less than 4,05mm^2 in cross sectional area drawn into 20mm or 25mm diameter conduit run between the switchboard and the socket outlet.

Circuits shall be arranged as detailed in the Project Specification.

15.5.2 Three Phase Socket Outlet Circuits

Three phase socket outlet circuits, rated up to 32 A, shall comprise 4 conductors not less than 6mm^2 in cross sectional area drawn into a 32mm diameter conduit run between the distribution board and the respective socket outlet position.

Circuits shall be arranged as detailed in the Project Specification.

All three phase socket outlet circuits will be earth leakage protected.

[redacted]

15.6 **GENERAL LABELLING**

The Contractor shall label all power outlets, isolators and light switches.

The prefix capital letter(s) of any outlet refers to the distribution board from which it is fed. The next numeral after the letter(s) indicates the circuit, e.g. Circuit No. 2 fed from Distribution Board 1 = SUB DB 1.1/CB.

[redacted]

15.7 WET WELL LIGHTING

15.7.1 Introduction

Wet wells require cleaning from time to time to prevent damage to the pumps. Cleaning is manually done. Cleaning staff require sufficient lights in order to properly clean wet well.

Furthermore, their safety is a non-negotiable. In a sewage system, hydrogen sulphide and volatile organo-sulphur compounds are considered to have the greatest potential of creating health risks, apart from the odour nuisance. Even low concentration of them can cause significant health problems.

This specification seeks to specify appropriate light fitting along with other ancillary parts under such conditions as may be suitable for workmen.

15.7.2 Scope

Design, manufacture, testing and delivery of the complete units of portable lights, portable gas monitors or permanent fixed gas monitors; cables, glands and joint boxes for various sites of the City of Cape Town sewage pump stations.

15.7.3 Supply

The supply to the light fitting shall be made available from locally manufactured sockets. The supply voltage to the portable light shall be 230V, 50Hz single phase-to-neutral supply voltage. Switched sockets shall be of construction specified by EAM D&C general specification (16.4.2).

15.7.4 Selection of equipment

In order to select the appropriate electrical equipment for hazardous areas, the following information is required:

Classification of the hazardous areas including the equipment protection level requirements where applicable, external influences and ambient temperature.

15.7.5 Cables

The cable shall be a minimum length of 10 meters; extra meters shall be site specific. The cable or cables to be used shall be IP 65 rated and classified for zone 1 use. Cable from the MCC to junction box or distribution board shall be a minimum of 25mm^2 Cu 4c copper cable PVC fire retardant.

Cables for fixed installations

Cables used for fixed installations in hazardous areas shall be appropriate for the ambient conditions in service. Cables shall be:

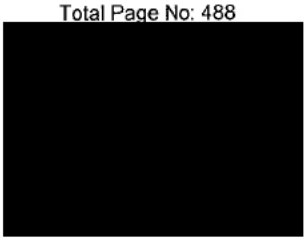
a) Sheathed with thermoplastic, thermosetting, or elastomeric material. They shall be circular and compact. Any bedding or sheath shall be extruded. Fillers, if any, shall be non hygroscopic; or
b) Mineral insulated metal sheathed; or
c) Special, e.g. flat cables with appropriate cable glands. They shall be compact and any bedding or sheath shall be extruded. Fillers, if any, shall be non-hygroscopic.

Cable Terminations

If multi-stranded and, in particular, fine-stranded conductors are employed, the ends shall be protected against separation of the strands, for example by means of cable lugs or core end sleeves, or by the type of terminal, but not by soldering alone.

15.7.6 Distribution Boards

If a distribution board is required, it shall be of construction specified by EAM D&C general specification (8.1.1.).



15.7.7 **Light fitting**

Selection of luminaires;

It shall be IP 65 rated and classified for zone 1 use. It must give sufficient light intensity prevent straining the eyes of the maintenance and operational staff.

Shall take into account the possibility of changes of the temperature class, if lamps with different wattages can be used.

Low-pressure sodium lamps shall not be transported unprotected through a hazardous area owing to the risk of ignition due to free sodium from a broken lamp. *(SANS60079-14 "Explosive atmospheres Part 14: Electrical installations design, selection and erection"*

Hand held Luminaires Classification

Luminaires shall be classified in accordance with the provisions of Section 2 of SANS/IEC 60598-1:

Type of protection against electric shock - class II or class III.

Method of connecting the cable or cord: re-wire-able hand lamps, or Non-re-wire-able hand lamps.

Construction shall be according to provisions of SANS 60598-2-8 Luminaires - Hand Lamps, paragraph 8.7

Adequate means shall be provided to prevent impairing of safety due to unintended short-circuiting of uninsulated accessible SELV conductors of opposite polarity.

Electrical connections to supporting conductors shall not be subject to mechanical tension.

Lamp holders shall comply with the relevant IEC specifications

Connectors for luminaires may be connected to the supporting conductor by means of pin contacts

Protection against electric shock 8.12

15.7.8 **Glands**

Selection of cable glands

They shall be IP 65 rated and classified for zone 1 use.

The cable gland shall be selected to match the cable diameter.

The use of sealing tape, heat shrink tube or other materials is not permitted to make the cable fit to the cable gland.

If a cable gland is to be used at an ambient temperature range different from –20 °C to 40 °C and/or an operating temperature higher than 80 °C this shall be covered by certification documentation.

The cable gland shall be selected to match the cable diameter. SANS10108_2017_Ed6Am1 (Hazardous Locations)10.6.2

15.7.9 **Joint Boxes**

It must be Ex & IP 65 rated and classified for zone 1 use.

15.7.10 **Gas monitors**

It must be Ex & IP 65 rated and classified for zone 1 use.

15.7.11 **Cable hooks**

It must be Ex & corrosion proof and classified for zone 1 use.



15.7.12 **Stakeholder Competency**

Responsible persons; Operators/technicians; Designers; shall have understanding of the general principles of types of protection and marking and of explosion protection; inspection and maintenance requirements of SANS 60079-17; equipment design aspects affecting protection concept.

15.7.13 **Plugs and sockets used for external connections**

Plugs and sockets used for the connection of external intrinsically safe circuits shall be separate from, and non-interchangeable with, those of circuits which are not intrinsically safe (Pg. 87)

[redacted]

16 SECURITY ALARM SYSTEMS (NEW)

16.1 Pepper Spray System

16.2 Introduction

This specification seeks enhance continuous improvement to ensure that the City of Cape Town's sites are protected against vandalism, theft of equipment, which negatively affects the service delivery to the members of the public.

The Standard Specifications for Electrical Works cover the general technical requirements with respect to material, installation, testing, commissioning and maintenance of electrical installations for the City of Cape Town.

The supplier shall be responsible for the supply, delivery, installation, testing and commissioning of all electrical and chemical equipment related to fully functional systems, compatible with CoCT infrastructure. This specification provides for the supply and installation of a master-slave pepper spray gas security system at various facilities within the City of Cape Town Municipality together with any repairs to any systems.

The supplier shall supply the specified pepper spray units complete with wiring, gas canisters, 24hr back up batteries, sirens, slave units, housing cubicles, Intrusion monitoring, GSM Modem complete with power supplies, IO Telemetry cards, aerial etc. for complete operation. The supplier will also be responsible for programming of the Telemetry or the GSM Modem. The services contained in this contract will have to be done as and when required by the City of Cape Town and installed within a time period and at a site anywhere within the municipal area as identified in the respective purchase orders. The primary option would be for the City to use its own sim cards and the use of 3rd party sim cards are purely for an as and when needed basis at the City discretion.

16.3 System Specifications

General requirements

The master and slave enclosures must be manufactured from mild-steel with powder coating and a minimum thickness of 1.6mm, unless otherwise approved by the CCT.

a) The enclosure must be electric red, unless otherwise approved by the CCT.
b) The mounting bracket must be a U, L or flat shape unless otherwise approved by the CCT
c) The system must be powered by a dedicated single phase 220V/AC supply from the existing distribution board.
d) The system must have a minimum of 48 hours back-up battery supply.
e) The system must be capable of interfacing with the existing telemetry system, SCADA system and deep sea controller.
f) The system must have a built in battery charger with short circuit protection.
g) The system must have Modbus communication
h) The system must have a GSM capability.
i) The system must be designed in such a way to prevent tampering.
i) (i) The enclosures must be lockable to prevent tampering.
i) (ii) A lockable wire mesh cage must be fitted to prevent tampering of the units.
i) (iii) The system must provide cell phone sms and email notification.
j) The system must have a minimum 2 year manufacturing warranty
k) The system must have its own standard siren.
l) The system must be armed/disarmed via keypad/remote/SCADA/digital IO
m) The gas canister must be a minimum volume of 500ml and a minimum of 65mm diameter with a minimum of 15% oleoresin capsium mixture.
n) The system must have relay outputs for the actuators and siren.
o) The system must allow a minimum of 15 remote programmable users.
p) The system must allow a minimum of 15 users to receive SMS notifications
q) The system must have PIR [passive infrared sensor] input protection, ESD [Electrostatic discharge] protection and PCB [printed circuit board] chemical protection.

[redacted]

r) All the work must be done according to SANS 10142 & occupational health and safety regulations.

s) The system must have a low power consumption to allow the backup batteries to last longer.

t) The system must have high quality receivers and remotes.

u) The system must have concurrent Modbus connection, Modbus communication, SCADA connectivity, USB programming, event logs, centralized configuration and expandability.

v) The system must have a high quality dual rectangular element, low noise, high sensitivity PIR sensor with a minimum detection speed of 3m/s and a minimum 10.6m radius coverage.

w) Each encrypted remote must have its own unique ID code in order to identify users arming and disarming the system for access control management.

x) Adjustable audible siren time

y) Support for External Status LED's

z) Each system must have the capability to accommodate slave units. The slave unit must be controlled from the same controller that controls the master unit.

aa) All master and slave units will have a sensor (PIR) installed as part of the unit. Each unit must have the capability that at least two additional sensors can be installed with the unit. The additional sensors functionality will be enabled or disabled by means of configuration software.

bb) Sensor to be able to operate in a high vibration and heat environment without generating alarms. Supplier to submit proposals for the approval of the CCT.

cc) Intrusion communication must be through a GSM link to the Operations Centre.

dd) User armed/disarmed and alarms must be date and time stamped.

ee) Provide technical training.

16.4 System configuration

The master unit must be programmable via a laptop and dedicated software. It is required that the following parameters have the functionality to be reprogrammed should it be required:

a) Spray time of both master and slave canisters

b) Re-activation time of the system

c) Location of the installation

d) Duration of audible alarm

e) Adding and removing of remotes to specific systems

f) Renaming of remote ID codes for access control

g) Adding and removing of SMS notifications

16.5 Communication

a) The Master Controller shall have an integrated GSM modem expansion slot. (Note External GSM units are not preferred.)

b) System must have the functionality to communicate via Modbus, TCP / IP, RS232 or RS485 with various telemetry unit and Deep Sea Electronics controller. The telemetry unit and Deep Sea Electronics controller will utilize the GSM modem/existing tetra network to communicate information to the Central Operation Centre.

c) Data must be capable of being transferred incrementally to the server.

d) Alarm to be sent through GSM SMS. Remote configuration of alarm mobile numbers must be possible.

e) Connection between field laptops and the controller must be wireless (Bluetooth) for safety and reliability reason (corrosion). If a laptop is not available on-site the device must have the capability to conduct a dial up manually.

f) The following alarms generated by the master controller will be communicated to TOC:

g) System status

h) Gas triggered

i) Gas stopped

j) Last user arming system

k) Last user disarming system

l) Canister gas levels



m) Battery voltage status
n) User armed/disarmed and alarms must be date stamped.
o) The following alarms generated by the master controller will be communicated via sms notifications to the operators:
p) Intruder alarm.
q) Power failure alarm
r) Low gas canister level
s) Low battery voltage
t) The supplier shall provide a suitable way of presenting the information in a user friendly way to the operator/s in the operations centre. The following pages must be set up:
u) Overview of installed units
v) Individual page for each unit displaying the status of the parameters as specified.
w) Be able to create alarm conditions when pre-set levels are exceeded.
x) Event page.

16.6 SCADA

The following SCADA pages must be setup at the different area control rooms as required:

a) Overview Mimic displaying all installed pepper systems in the specified area.
b) Individual Mimic page per site displaying the status of each installed unit
c) Event page that log all history i.e. System Armed, System Disarmed, Alarm Status, Power Failure and Door tamper. All events must be date stamped.
d) Remote ID register page in order to identify all remote carriers.
e) Should it be required the tenderer will at his own cost demonstrate the offered system to the City of Cape Town officials prior to tender award.

16.6.1.1.1 SCADA Reporting

The SCADA must generate an email based report for the following reports:

a) Access Control via remote ID TAGS
b) Power failure
c) System Status
d) Battery Status
e) Pepper Gas Activation Alarm
f) Gas canister level

16.6.1.1.2 Data storage

The system must to be capable of storing one-year data for all channels at the standard 15 minute logged interval.

The service provider is required to store data on a secure platform. The service provider needs to indicate where they will store data.

16.7 Installation of a pepper spray system

16.7.1 Master Unit

a) Supply and install a prewired master pepper spray unit.
b) The enclosure must be epoxy coated mild steel with a minimum thickness of 1.6mm unless otherwise approved by the CCT.
c) The colour of the enclosure must be red unless otherwise approved by the CCT
d) The enclosure must be approximately ±350x300x80 (HxWxD).
e) The unit can have a built in or externally wired DIGI 85 PIR or equivalent.

[redacted]

f) The master unit must consist of a chemically protected pcb, canister controller, supply voltage connection, battery charger, short circuit protection fuse, battery, canister, built in siren, Modbus communication, PIR, PIR inputs, actuators, relays, ESD protection, receiver, Modbus card, serial port, SCADA connectivity and etc.

16.7.2 Slave Unit

a) Supply and install a prewired slave pepper spray unit.
b) The enclosure must be epoxy coated mild steel with a minimum thickness of 1.6mm unless otherwise approved by the CCT.
c) The colour of the enclosure must be red unless otherwise approved by the CCT
d) The enclosure must be approximately ±350x300x80 (HxWxD).
e) The unit can have a built in or externally wired high efficiency DIGI 85 PIR.
f) The slave unit must consist of a chemically protected pcb, canister controller, supply voltage connection, canister, PIR, PIR inputs, actuators, relays, ESD protection, receiver and etc.

16.7.3 GSM Card

a) Supply and install a GSM card in the master unit.
b) The operating frequency must be a quad band of between 850 and 1900MHz.
c) The Tx power can either be 2W at 850/900MHz or 1W at 1800/1900MHz.
d) The Rx sensitivity can either be 850/900MHz at 109dBm or 1800/1900MHz at 108dBm.
e) The sim card can be a standard, micro or nano size.
f) The data features can either be SMS: PDU & text mode or SMS: cell broadcast
g) The GPRS must be a class B

16.7.4 MODBUS Card

a) Supply and install a MODBUS card in the master unit.
b) The communication link can either be RS232/RS485.
c) The supported speed must be between 2400 and 115200.
d) Configuration must be through the main controller.

16.7.5 Keypad/Biometric Device

a) Supply and install an IP66 security keypad/biometric device with a metal lockable enclosure.
b) Options should be provided for a keypad/biometric reader can be used to activate and deactivate the pepper spray system on site.

16.7.6 Two button remote control

Supply encrypted two/three or four button remote control to activate and deactivate the pepper spray system on site.

16.7.7 Warning signs

a) Supply and install weather resistant warning signs outside the property.
b) The warning sign must ±400x400mm and of a high intensity reflective nature.
c) The signs must be written in all three Western Cape official languages.

16.7.8 Pepper spray canister

d) Supply and install a minimum of 500ml pepper gas canister with a minimum of 15% oleoresin capsicum
e) Mixture



16.7.9 **Circuit breaker**

Supply and install a single phase 5A and 10A mcb in the existing distribution board to power the pepper spray system.

16.7.10 **PVC conduits**

Supply and install 20mm PVC conduits with knocking nails and spacer saddles

16.7.11 **Pad locks**

The contractor shall make provision to supply and install 30 mm brass padlocks on all MCC doors, glanding section and bus bar section plates. The locks shall be keyed alike to the existing 30mm brass padlocks used in the respective area and region.

16.7.12 **Wire mesh cage**

Supply and install a approximately ±370x320x100 (HxWxD) shot blasted & powder coated mild steel cage with a minimum thickness of 4mm unless otherwise approved by the CCT.

The colour must be red unless otherwise approved by the CCT.

The cage must be pad lockable.

16.7.13 **Power cable**

Where needed power cable shall be provided. Cable shall be of the the uv resistance 1.5mm x 3 core surfix type.

16.7.14 **LED light**

Supply and install a status indication high efficiency weather resistant 5mm high brightness blue LED light with a holder near the entrance of the building.

16.7.15 **PIR**

Supply and install a DIGI85 or equivalent high efficiency, high sensitivity, low noise dual rectangular element PIR with a minimum detection speed of 3ms and minimum 10.6m radius coverage.

16.7.16 **Battery**

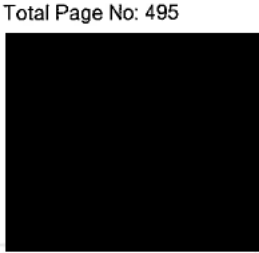
Supply and install an 18Ah, 12V high efficiency maintenance free battery set to provide a minimum of 24hour backup supply to the pepper spray system.

16.8 **Interfacing the systems**

a) Interface the pepper spray system with the existing telemetry system, security alarm system, ventilation system and deep sea controller.
b) The ventilation system must stop operating once the pepper spray system is triggered.
c) Supply and install all required material needed to successfully interface the systems.
d) Configure the communication between the systems.
e) The tenderer shall ensure that that the individual interfacing pepper spray systems with various telemetry systems like SSE, Spectrum, Motorola and equivalent are competent and familiar with the environment.

16.9 **SCADA**

a) Set up an overview mimic of the system per control room per site.
b) Setup and vent page per control room per site.
c) Configure SCADA reporting via email and sms.
d) Trouble shoot and repair the system when needed.
e) tag database configuration.



f) Configure remote ID lookup of names database per control room per site.

g) The tenderer shall ensure that that the individual interfacing pepper spray systems with SCADA systems like Adroit,Codra,Ignition,ATVISE and equivalent are competent and familiar with the environment.

16.10 **Training of staff on pepper spray system**

The service provider is required to train internal staff on how to install, commission, maintain, operate and troubleshoot on the system. The service providers' competent representatives will therefore be required to train a team of up to 15 internal staff on setting, commissioning and maintaining the controllers. This training includes 4 hour session. The CCT will provide the venue for the training. This payment item covers all activities required to successfully complete the work but it excludes the venue of the training and lunch

16.11 **Stripping and repairing the pepper spray system**

The cost shall cover troubleshooting to identify any fault and conducting the repair of the system. The parts for the repairs shall be provided from another payment item.

16.12 **Occupational Health and Safety Specification**

The supplier should take note of the Health and Safety Specifications that are attached to this tender document in Annexure 8

[redacted]

16.13 DRAWINGS

16.13.1 Standard Diagram

The following drawings are supplied with this tender in Annexure 9 as an indication of what is expected. Each supplier can provide an enclosure to their own design provided it meets these general requirements.

Drawing	Description	Paper Size
EAM-EE-2016-009	Pepper Spray enclosure with mounting bracket	A3
EAM-EE	Pepper spray wire mesh cage	A3

Suppliers Drawings (As per Annexure A)

The following drawings must be provided to the CCT in hard copy and electronic format (pdf and dwg format) for every installation:

a) Workshop drawings of the proposed pepper spray system as well as any other new installation in this project are required for approval by the CCT prior to fabrication.

b) Record drawings (termed "as-builts") of the installation indicating cable routes, equipment positions and circuit wiring details are required on completion. All these record drawings must be checked and signed by the supplier/sub-contractor before submission to the CCT.

c) A full set of schematic drawings and wiring diagrams shall be handed over at the end of each installation; including positions of all junction boxes and general equipment arrangement.

The Contract will be deemed incomplete until the Supplier has handed all these drawings over to the CCT who shall provide his final acceptance in writing.

16.13.2 Uniformity

All items of the same type of equipment shall where at all possible - be of the same make and type for each item throughout the installation, to ensure interchange ability and ease of maintenance.

16.13.3 Equipment To Be Supplied And Installed

The CCT reserves the right to call for samples of the equipment offered, to inspect the workmanship as the work proceeds and to either accept or reject the equipment, or workmanship. The CCT's approval of the design, materials and workmanship shall in no way reduce the Supplier's liability to provide a complete and proper working plant which is abreast with modern technology.

All such samples may be retained until completion of the Contract. All such samples shall have securely attached thereto labels designating the Contract by name and number (if any), the name of the Supplier and any further relevant information.

16.13.4 Suppliers Staff

The work shall be done by, or at all times be under the personal supervision of an installation electrician appointed in writing by the Supplier as the Responsible Person, in terms of the requirements of the Machinery and Occupational Safety Act. This person shall be available during working hours, and shall be experienced in projects of the specified.

The CCT may, if he deems fit, require that the Supplier removes or causes to be removed an employee of his from the specified premises by virtue of that person's incapability, appearance or any such reason which in the opinion of the CCT, is valid.

At all times while on the specified premises, all artisan and labourer members of the Supplier's staff shall wear clothing adequately marked with the Supplier's name or acceptable identification.

The Supplier shall maintain the involvement of the following key personnel as the exigencies of this contract require:

Position	Minimum requirements	Min Staff required

[redacted]

Electrician	Qualified Electrician with a wireman's license and 3 years post experience	1
Technician	Pepper Spray Installations N6 or National Diploma Electrical Engineering, with 3 years post experience in pepper spray installations or OEM certified	1
Technician	SCADA and Telemetry Installations, National Diploma in Electrical Engineering related field with 5 years post qualification experience in SCADA and Telemetry systems installations and configuration or OEM certified	1

It must be understood that more than the minimum number of key personnel (stated below) may be required in order to fulfil the tenderer's obligations. Where the staff members are not in the employment of the entity, the entity shall obtain a Memorandum of Agreement for the staff member, indicating the commitment for the duration of the contract. The Supplier/Tenderer shall provide CV and a copy of the qualification of the individual listed for the specific position in line with the minimum requirements. Failure to complete schedule 15A and providing the accompanying documentation (CV and copy of qualification) may lead to disqualification of such a bid.

16.13.5 **Inspection By Authorised Officials**

The Supplier shall allow for the provision of adequate and safe means of access to facilitate the proper checking and inspection of the Works by the CCT's representative(s).

No work will be accepted as complete unless approved by the CCT's representative, and approval will not be possible in the absence of a properly conducted inspection.

Such inspections by the CCT's representative must be called for at reasonable notice, and sufficient opportunity and facility afforded for the inspection to be carried out in the presence of the Supplier or Supplier's designated agent.

16.13.6 **Employment Of Security Personnel**

All security staff employed by the supplier on behalf of the CCT or at any CCT property must be registered with Private Security Industry Regulatory Authority (PSiRA). Proof of such registration must be made available to the CCT's agent upon request. Security will be at the tenderers discretion and cost.

16.13.7 **Forms For Contract Administration**

The supplier shall complete, sign and submit with each invoice, the following:

a) Monthly Project Labour Report (Schedule 12: Annexure 3) – Not applicable

b) B-BBEE Sub-Contract Expenditure Report (Schedule 12: Annexure 4).

c) Joint Venture Expenditure Report (Schedule 12: Annexure 5).

The Monthly Project Labour Report must include details of all labour (including that of sub-contractors) that are South African citizens earning less than R350.00 per day, as adjusted from time to time (excluding any benefits), who are employed on a temporary or contract basis on this contract in the month in question.

In addition to the Monthly Project Labour Report the Supplier shall simultaneously furnish the CCT's Agent with copies of the employment contracts entered into with such labour, together with certified copies of identification documents as well as evidence of payments to such labour in the form of copies of payslips or payroll runs. If the worker is paid in cash or by cheque, this information must be recorded on the envelope and the worker must acknowledge receipt of payment by signing for it and proof of such acknowledgement shall be furnished to the CCT's Agent.



The Monthly Project Labour Reports shall be completed and submitted in accordance with the instructions therein.

The B-BBEE Sub-Contract Expenditure Report is required for monitoring the supplier's compliance with the sub-contracting conditions of the Preference Schedule.

The Joint Venture Expenditure Report is required for monitoring the joint venture's/consortium/partnership compliance with the percentage contributions of the partners as tendered, where the joint venture/consortium/partnership has been awarded preference points in respect of its consolidated B-BBEE

[redacted]

17 DUCTS, CONDUITS, CONDUIT RUNS AND DRAW WIRES

All conduits and conduit accessories shall be PVC, shall conform to SANS 950 and shall be concealed in walls, concrete floors or structures, and roof spaces, as far as possible. Conduit may be galvanised steel with screwed electric thread where specified.

Every effort shall be made to obviate chasing and the Contractor shall build conduits into walls and floors as the building work proceeds.

Where chasing is necessary the chases shall be as narrow as possible and shall be carried out by machine. Once the conduits have been installed they shall be secured to prevent springing whilst the brickwork is being made good. Chasing of concrete will not be permitted.

Where conduit is installed in concrete floor slabs the conduits shall not cross one another and shall be adequately spaced to permit the satisfactory consolidation of the concrete.

The conduits installed in the concrete slabs shall be kept well clear of the underside and top of the respective slabs. The conduits shall be installed so that any condensation that may form inside the conduit will gravitate to the nearest box.

An electrician shall be standing-by whilst the Contractor is casting concrete over any conduits.

Holes, slots and cable trenches will be formed in the structure as the building work proceeds. The Contractor shall ensure that his conduits are kept well clear (at least 300 mm) from these penetrations when placing conduits for casting or building into the structures.

Conduits are run in brickwork and are required to pass through a concrete column or beam, a conduit sleeve shall be cast into the column concrete. As the brickwork is raised the required conduit shall be installed through the sleeve.

Deep concrete boxes shall be employed in preference to shallow boxes fitted with extension rings.

All conduits shall be installed to permit the wiring to be "looped in".

Surface mounted conduit shall be subject to the approval of the Engineer.

All boxes shall be fitted with cover plates where they are not covered by lighting fittings or other devices. All conduit for surface mounted lighting fittings shall terminate with conduit boxes and shall be arranged to permit back entry to each lighting fitting. The conduit boxes shall be securely fixed, flush with the underside of the ceiling or wall.

All ducts, spare conduits and conduits for other services shall be clear, water and moisture free and fitted with 2,0 mm diameter galvanised steel draw wire.

All PVC pipes installed as cable sleeves shall be provided with bends, where necessary, with a minimum radius of 600 mm.

Galvanized steel conduit Bosal (similar and approved) shall be used in the following instances: where conduit and accessories are exposed to ultra violet radiation for more than an hour a day; where flame or explosion proof installations are required; and

Where the conduit will be load bearing e.g. for the suspension of lighting luminaires. When specified in the Scope of Works.

Conduits shall not be installed closer than 150mm to pipes containing hot water, steam, gas or any other material which may damage the conduits or conductors.

PVC conduit shall be secured with saddles spaced not more than 900mm apart.

Metal conduit shall be secured with saddles spaced not more than 1500mm apart.

18 POWER SKIRTING

In general, three-compartment power skirting manufactured from high impact PVC is preferred.

The compartments shall be utilised for the following services:

a) Top compartment (80mm high)

b) Power cabling and socket outlets
c) Centre compartment (40mm high) Computer services
d) Bottom compartment (40mm high) Telephone services

All compartments of the skirting shall be approximately 35mm deep. All cover plates, end covers, elbows, bends and other fittings for the power skirting shall be provided from the same manufacturer's range of equipment as the power skirting and shall match aesthetically and mechanically.

Flush mounted, round, conduit draw boxes shall be provided in the wall behind each compartment of the power skirting. A 50mm diameter hole shall be provided in the back of the top compartment and 40mm holes shall be provided in the back of the remaining compartments, at positions coincident with the flush mounted conduit boxes, to facilitate the drawing-in of cables and conductors.

Each compartment shall be provided with its own 25mm conduit and box. The conduit coupled to the power compartment shall be run to the respective distribution board (whilst the conduits coupled to each of the remaining two compartments shall be run in accordance with Schedule G.

19 WATER HEATERS & CIRCUITS

19.1 INSTANT WATER HEATERS

Instant water heaters shall be Zip "Hydroboil" or similar. Units shall be designed to operate up to 400 kPa. Units shall be equipped with safety controls to protect against water or power failure. The water temperature shall be maintained within 1°C of boiling point at all times. Units shall have a white polyester powder coated finish. The 5 litre unit shall be equipped with a 1500Watt element. The Instant boiling water dispenser recovery rate shall be1 cup per minute. The 10 litre unit shall be equipped with a 2400Watt element. The Instant boiling water dispenser recovery rate shall be1.5 cups per minute.

19.2 GEYSERS

Geysers shall be fitted with a robust galvanized outer casement and be rated for domestic and commercial applications. The unit shall be durable in severe weather and climatic conditions. The cylinder shall be thermos-fused porcelain enamel-lined, polyurethane insulated and environmentally friendly. It should be possible to install the cylinder horizontally or vertically via adjustable left and right-hand wall mounting brackets.

19.3 CIRCUITS

Water heater circuits shall comprise 4mm² PVC insulated copper conductors drawn into a 25mm diameter conduit terminating in a surface mounting box containing a 30 A double pole isolator. From the isolator a length of 25mm diameter flexible conduit (not exceeding 700mm in length) and fitted at each end with an approved adaptor shall be run to the water heater terminal box. The circuit phase conductors shall be interrupted by the isolator but the mandatory earth continuity conductor shall be run from the distribution board, through the isolator box, to the water heater earthing stud, in one continuous length without joints.

[redacted]

20 LOW VOLTAGE, CONTROL AND SIGNAL CABLES

20.1 GENERAL

All cables indicated on the drawings and schematics shall be designed and selected according to the loadings, generally as detailed in the Project Specification.

A maximum total volt drop of 2,5% is allowed across the cable from the MCC to the motor terminals under running conditions.

All conductors used in the electrical installation shall be high conductivity, annealed copper with PVC insulation and shall comply with SANS 1507.

No joints will be permitted in any low voltage cable run, except where cable lengths exceed the drum length, without prior written acceptance by the Engineer. Any damaged cable shall be replaced by the Contractor at his own cost.

All cables shall be suitably rated.

20.2 CABLE TRENCHES

The cable trenches shall be as per project specification to suit environment, but shall generally be a minimum of 450 mm wide x 750 mm deep. The trenches shall contain no stone or sharp objects and shall be inspected by the Engineer prior to backfilling.

For the purpose of this Subcontract, only three classes of material are considered and all excavated material shall be classified according to the following:

Type (as measured) in this document	General Description	Formal Classification to SANS 1200
Soft excavation	Excavation by pick and shovel in soft soil	Soft Excavation
Intermediate excavation	Possible by use of pneumatic tools and equipment	Intermediate excavation: Boulder excavation Class A Boulder excavation Class B
Hard rock excavation	Removal of material by blasting	Hard Rock excavation

The cable trenches shall conform to Drawing EAM-EE-GS-006 entitled "Typical Multiple MV/LV Cable Trench Arrangement".

The Contractor shall provide all cable trenches. The Contractor shall be responsible for any damage to any services which may exist on the site and shall cover all costs incurred for the repair of any services which are damaged during the trench excavations

Although a minimum cable trench width has been specified, the installation of two or more cables shall result in the Contractor engineering the actual cable trench width to ensure that all cables are not underrated.

Trenching that is to be undertaken within the existing MV substation shall be by hand and supervised by a competent person, approved by the Engineer. No trenching machines will be allowed within the Existing MV substation and MV equipment area.

The Directorate Water and Sanitation City of Cape Town may assist with the identification of existing cables depending on availability of equipment. The onus lies on the Contractor to ensure that services have been adequately surveyed and recorded prior to excavation.

All backfill material shall have enough moisture content so as to allow for good compaction. Backfill material shall be laid in layers to a depth of 150mm and then compacted by a compaction machine, suitable for the work at hand. The contractor shall ensure that the cable bedding sand and backfill is of a good quality to ensure that the thermal resistivity of the ground is at least improved.

[redacted]

All trenching shall conform to the standard as laid down in SANS 10198.

The contractor shall also ensure that the cable trenches are properly fenced off at all times until the cables have been installed and the trenches backfilled.

Danger tape shall be installed as specified.

The cable trench shall be shored with timber boards where required to ensure safety to workers and the public and facilitate ease of installation.

All trenching shall be inspected by the Engineer prior to backfilling.

20.3 CABLE ROUTES

Control and instrument cables for the project may be run on the same cable tray as the power cables but where electromagnetic interference may upset the control signals the necessary precautions regarding screening and physical separation shall be applied.

Cable routes indicated are merely indicative of the points to be connected. The Contractor shall ascertain whether that route is the most suitable and feasible. The contractor shall order the cable accordingly.

20.4 CABLE ROUTE MARKER

Cable route markers shall be installed every 50m in straight runs and at every change of direction. These shall be of concrete pyramid type, with engraved aluminium label as detailed on Drawing EAM-EE-GS-004 entitled "Cable Route Marker".

20.5 CABLE SUPPORT SYSTEMS

20.5.1 GENERAL

Cable support system shall be wide enough to accommodate the cables specified in this contract plus 25% spare capacity for future expansion.

Pricing for cable support systems on the schedule of rates shall include all supplementary materials required to form a complete installation e.g. mounting bolts and nuts, brackets, threaded rods, chemical or mechanical anchors, "unistrut" (equal and approved), canter lever arms, T-pieces, risers, droppers, horizontal bends, 4 way cross overs, "Clip-On" support channels, joiner or splice sets and hold down saddles etc.

20.5.2 MATERIAL AND MANUFACTURE

Cable support system shall be of the heavy duty type manufactured from mild steel and hot dipped galvanized after manufacture, designed for internal and external use.

Should the environment be considered corrosive the Employer may call for 316L stainless steel. The contractor shall confirm the type of material before ordering.

20.5.3 INSTALLATION

Cable support system shall be plumb and shall length wise be arranged either vertically or horizontally. Joints in the cable support system shall be kept to a minimum and shall be properly braced. Bends and tees shall be from the same manufacturer.

Cable support system fixed to brick or concrete work shall be mounted on "unistrut" brackets manufactured from 2.5mm thick material. The brackets shall be the full width of the ladder and shall be spaced 500mm centres along the length of the tray. Brackets shall be provided where cable trays terminate. Each bracket shall be fixed to the brick or concrete work with two (2) 8mm bolts entered at least 70mm into the concrete. The tray shall be secured to each bracket with two (2) 6mm galvanized steel set screws with nuts and washers.

20.6 CABLE LENGTHS

Cable lengths indicated in the Project Specification are employed for voltage drop calculations only and shall not be used as a basis for re-measurement. The onus is on the Electrical (Sub)

contractor to adequately survey the site and measure and price the power and control cabling installation as an all-inclusive complete item. Should a deviation be required due to unforeseen site conditions, the Schedule of Rates for the Electrical Installation shall be applicable to calculate the difference in cost for the installation of power and control cables, but only with the approval by the Engineer.

20.7 POWER AND INDICATION CABLES (1000/600 VOLT)

All power and indication cables shall be of the multi-core stranded soft drawn copper wire PVC insulated PVC bedded, steel wire armoured type with an overall PVC sheath (preferably black) and shall be manufactured and tested in accordance with SANS 1507 for general purpose duty.

The colour of the cores shall be as follows:

Twin core: one red, and one black.

Three core: one red, one white and one blue.

Four core: one red, one white, one blue and one black.

20.8 INSTRUMENTATION CABLES (24V / 220V)

Instrumentation cable shall be constructed of multiple twisted pairs of insulated stranded copper wire, PVC insulated with an overall aluminium shield, extruded PVC inner jacket, served with steel wire armour with an extruded PVC outer jacket.

The nominal conductor resistance shall not exceed 3,5 ohms per 100 m at 20°C.

The complete cable shall withstand a dielectric test conductor to conductor and conductor to shield of 1 000 V dc for one minute.

The insulation resistance of each conductor shall be not less than 8 800 meg ohms/km for 1 minute at 500 V and 20°C, measured with the remaining conductors in the cable connected to the armouring.

The minimum core size shall be 1,5 mm².

All instrumentation and signal cables (excluding optical fibre cables) shall be installed separate from power cables.

20.9 OPTICAL FIBRE CABLES

The optical fibres shall comply with SANS/IEC 60793 and the optical fibre cables shall comply with SANS/IEC 60794 and shall be installed in accordance with SANS/IEC 60794.

All cables or cable lengths shall be supplied along with Factory Test Certificates. Cable ends shall be suitably made off / protected to avoid water ingress, damage etc. while in storage.

The cables shall be of the multimode type, suitable for direct burial in the ground.

A cable shall contain 12 fibres packaged in two tubes and the fibres shall be to the following specification:

Core diameter	50 microns
Cladding diameter	125 microns
Primary acrylic buffer	250 microns diameter
Category	A2
Wavelength	850nm
Attenuation	3dB/km maximum
Bandwidth	400-600 MHz/km

The cables shall be constructed to the following specification:

a) tubes shall not be filled with water blocking compound
b) the cable core shall be filled with water blocking compound

[redacted]

c) the cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain of more than the limits specified by the manufacturer

d) a moisture barrier shall be provided by a metallic tape applied over the cable core with a longitudinal overlap and bonded to the sheath

e) the inner sheath shall be made of polyethylene

f) the cable shall be armoured with Corrugated Steel Tape (CST)

g) the outer sheath shall be a seamless sheath made of UV-stabilizer weather-resistant polyethylene in accordance with Clause 22 of SANS/IEC 60708-1(To be updated with latest Standard)

h) the outer sheath shall be marked with the manufacturer's name and "Optical Fibre Cable" as a single line of marking at intervals not exceeding 1000mm

i) Optical elements and each fibre with a cable element shall be uniquely identified by colours.

Cables shall be subjected to the following tests in accordance with SANS/IEC 60794-1-2:

a) tensile performance
b) cable bend
c) crush
d) temperature cycling
e) water penetration

In addition, compatibility with the particular installation conditions shall be demonstrated though the following tests:

a) Impact
b) Kink
c) Torsion
d) Sheath abrasion resistance

20.10 PANEL WIRING (24V / 220V)

Further to the abovementioned Clause, all panel wiring shall be of the silicone-insulated type with stranded tinned copper conductors, with a minimum conductor size of 1mm ^{2}.

The colour of the conductors shall be as follows:

a)	220V AC control Line	Brown
b)	220V AC Neutral	Black
c)	+24V DC	Orange
d)	-24V DC	Violet or Purple

20.11 PLC WIRING

Further to the abovementioned Clause, all panel wiring shall be of the silicone-insulated type with stranded tinned copper conductors, with a minimum conductor size of 1mm ^{2}.

The colour of the conductors shall be as follows for Digital Signals:

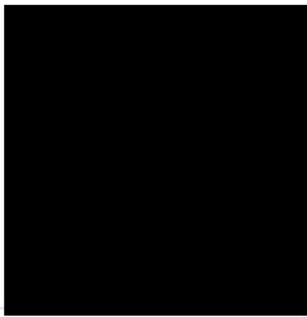
a)	PLC DIGITAL Inputs	Grey
b)	PLC DIGITAL Outputs	Pink

The colour of the conductors shall be as follows for Analogue Signals:

a)	PLC ANALOGUE Inputs	twisted pair Red/black
b)	PLC ANALOGUE Outputs	twisted pair White/black

20.12 SPARE CORES IN ALL CABLES

All cables installed shall include for spare cores. The spare cores shall amount to 10% of the number of cores used, rounded up to the nearest whole core.



20.13 **CABLE IDENTIFICATION**

A suitable tag, onto which the appropriate cable identification number in accordance with the Contractor's detailed cable schedule shall be stamped, shall be adequately secured just below the gland at the ends of each cable.

Where cables deviate from one route to another (e.g. at tee's, on cable trays or in trenches) additional identification tags with numbers shall be fitted to each cable, within 500 mm of the point of deviation.

20.14 **CABLE SCHEDULES**

The Contractor shall submit to the Engineer a detailed schedule of all cables together with drawings showing cable routes (both underground and on cable trays) for approval prior to the commencement of laying such cables.

21 LOW VOLTAGE ELECTRICAL MOTORS

Reference shall be made to the General Mechanical Specification.

[redacted]

22 FIELD INSTRUMENTATION

22.1 GENERAL

The specifications for equipment to be supplied are as detailed below and within the Project Specification.

The Contractor shall include for all cabling required ensuring operation of the equipment as described in the Project Specification.

22.2 ULTRASONIC LEVEL DETECTORS

Ultrasonic Level Detectors shall be Mowbrey MSP 900GH or Enderss Hauser (or equivalent) and shall be of robust design.

(a) Generic

Ultrasonic level detection shall be by means of a transducer and separate transmitter, with the sensor powered via the transmitter. The sensors shall be mounted on suitably sized brackets of glass fibre reinforced construction, stainless steel or similar non-corrosive material directly over the medium being monitored.

The sensor shall have a stainless steel diaphragm and shall be equipped with an integral cable of 10m length, with the complete unit of at least IP65 rating. The sensors shall be capable of measuring range as set out below.

The transmitter shall be of minimum IP65 rating, or alternately, housing in a protective enclosure providing this rating. The transmitter shall have a local display, which shall be visible with the protective housing closed, if provided.

The transmitter shall be capable of bi-directional communication via a Modbus Plus network with the programmable logic controller.

The unit shall conform to the following:

Power supply	230 V AC
Output	Isolated 4-20 mA
	Relay (discreet outputs) as detailed
Calibration	Independent adjustments for zero and span
Accuracy	1% of span or better
Repeatability	0,2% of span
Resolution	0,1% of span or 2mm, whichever is greater
Dead band	< 0,2% of span
Ambient temperature effect	< 0,5% of maximum span per 10°C change

(b) Differential Level measurement over inlet channel

Two ultrasonic sensors with common transmitter, shall be mounted over the inlet channel for control of the screen.

The sensors shall be mounted one upstream and one downstream of the screen on suitable brackets manufactured from either 304 Stainless Steel or glass reinforced polyester.

Medium	Raw sewage
Measuring Range	0 – 2,0 m
Outputs	4 – 20 mA
	2 Relay

22.3 FLOW METERS

The flowmeter casing shall be aluminium, the flow transmitter remote from the primary element. The transmitter assembly shall be at least IP65 rating and suitable for operation with either a 24V DC or 230 V AC power.

The output of the flowmeters shall be 4-20mA and shall also include a pulsed signal.

[redacted]

23 UNINTERRUPTIBLE POWER SUPPLIES

23.1 GENERAL

A UPS shall be provided for each separate piece of equipment such as a SCADA computer or a PLC. Specific requirements are as detailed in the Project Specification.

The UPS shall include an alarm panel, serial connection to a SCADA server and adequate batteries for 30-min backup.

Critical alarms, warnings and readings shall be logged and displayed on all available user interfaces.

23.2 UPS SPECIFICATION

The UPS's shall be to the "RIELLO" Catalogue model Sentinel XR (or equivalent), comply with the following specification for high availability, high stability under varying supply and varying loads, or equivalent.

Rated input voltage:	230 V (+/-15%) at 50 Hz (+/-5%) single phase (Without having to supply a CVT line conditioner).	
Rated output:	230 V (+/-1,5%) at 50 Hz, single phase voltage	
Inverter rating:	Dynamic regulation at 100% load application / removal	Transient Recovery + 5% recovering to 1% within 10 m sec.
	LOSS of AC supply	No change.
	Total harmonic distortion	Better than 3% (Linear load).
	Overload capacity	120% (10 seconds).
Power rating	Sufficient to power all equipment as specified including PLCs as well as the PLC Data	Network equipment and fibre optic transceivers
Rated stored	Standard with 30 minutes range energy time	
Interfaces	SCADA:	Microprocessor serial interface (SNMP) Modbus TCP/IP open communication protocol card LCD Status display
Preferred Equipment	Riello XR Online, double conversion Batteries for UPS to be 10 year long life units	

23.3 INSTALLATION

UPS output shall be cabled to equipment to which it shall be supply. If Plug Socket Outlets are required, these shall be 15A red top plugs (dedicated).

24 HUMAN MACHINE INTERFACE (HMI)

24.1 GENERAL

If any Human Machine Interface (HMI's) are offered, the preferred (HMI's) shall be Schneider "Magelis XBT GT or equivalent. The HMI for certain plants where processes and logging of data is required, shall be upgraded to include, additional dynamic memory as required for the application.

25 PROGRAMMABLE LOGIC CONTROLLERS (PLC's)

25.1 GENERAL

A standalone programmable logic controller (PLC) shall be provided for the control of the equipment as described in the "Control Philosophy" section of the Detailed Specification (Section D) or the Project Specification. Allowance shall be made within the PLC equipment supplied for the future control of the entire existing and proposed plant as described in the specification and as detailed with the Proposed Single Line Diagram as referred to in the Project Specification. PLC equipment selection shall be done in accordance with the plant infrastructure for ease of

current or future integration. The responsible Engineer/Project Manager shall confirm the current/future infrastructure needs.

MODICON M340, Siemens S7- 1500, Allen Bradley ControlLogix programmable logic controllers or equivalent shall be supplied and installed with single or double rack configurations. A separate Ethernet (10/100 - RJ45 - Modbus TCP) module shall be installed on the configuration rack when Ethernet Based Communications is used.

MODICON M580, Siemens S7 -1500, Allen Bradley ControlLogix or equivalent programmable logic controllers shall be supplied and installed with multiple rack configurations and/or larger numbers of Remote IO or Distributed IO.

When equivalent Programmable Logic Controllers are proposed, the Process Engineer/Project Manager shall approve it in line with maintenance strategies and capabilities. The Programmable Logic Controller shall be accompanied by the relevant latest licenced software and programming tools and training where applicable. Certified Training, licencing and genuine software for at least 5 staff members shall be catered for upon verification by the project manager for the need.

25.2 EQUIPMENT SPECIFICATION

Hardware shall be field-proven under similar conditions and shall be suitably protected against excessive temperature, electrical interface, input and output overvoltage or short-circuit, and loss of program memory.

The equipment supplied shall incorporate a non-volatile form of program memory, which does not rely on an internal or external source of power to retain program memory in the event of a loss of normal power.

The CPU and I/O modules of the PLC shall be supplied with 20% excess program memory and I/O capacity for initial operation of all specified process components. However, the specifications of the PLC shall allow for future expansion of up to 50% additional memory and I/O capacity.

The PLC system shall be of a modular design with the mounting racks for the central controller, extension racks, power supply cards, central processing units interface cards, I/O cards, etc. interchangeable between the various nodes.

It shall be possible to code cards and slots to prevent the incorrect card being inserted into a given slot. Alternatively, the controller shall employ interrogation software, which shall detect the insertion of an incorrect module and prevent controller operation if an incorrect module is installed.

It shall be possible to change the modules without disturbing field writing. Connection blocks shall plug into the modules and shall be coded, to prevent connection blocks being plugged into the wrong modules. All modules shall have surge protection, which meets the IEEE-472 or similar standard.

All inputs shall have LED status indication on the modules. A maximum of 32 inputs with a single neutral shall be provided per module.

Output modules shall be of the opto-electric switched solid state relay (SSR) type. The module shall be able to withstand a peak load of 15A for one cycle and intermittent load of 9A for 3 cycles, per channel. For SSR type output modules, fuse terminals with blown fuse indicators shall be provided at the back of the PLC section of the board. Should the fuse fail to blow, then the fault shall only affect the switched output, and shall not affect the remaining outputs within the group. All outputs shall have LED indications.

For both the input and output modules, the LED's shall give a true load – side indication to and from the field devices.

Analogue input modules shall be of the multiple input range type. This may be either by means of plug-in type measuring range cards or by dip-switch selection. The input resolution of the module shall be a minimum of 12 bits. All inputs shall be individually isolated. Input modules with LED indication for "Communication Active" and "Out of Range" are preferred. Where a large number of analogue inputs with relatively slow changing values is required to be monitored, use



may be made of analogue multiplexer modules. The multiplexer shall be compatible with the analogue input module and shall therefore be supplied by the same manufacturer. The input resolution of the multiplexer shall be 12 bits.

Analogue output modules need not necessarily be of the full multiple output range type. The output resolution shall be 12 bits. The outputs shall be electrically isolated from each other. Output modules with "Communication Active" indicators are preferred. Galvanic isolation in the form of opto isolators shall be provided for all inputs and outputs and the driving logic of the modules.

The suppliers shall be permanently represented in Cape Town and shall guarantee the availability of local field service facilities and unit replacement ex-stock from the local depot, for one year after the completion of the defects liability period.

25.3 PROGRAMMING AND SOFTWARE

The Directorate: Water and Sanitation of the City of Cape Town is currently in possession of an unlimited site licence for UNITY, PLC programming software and accordingly, all equipment supplied shall be compatible with this software. When a need arises to deviate from the compatibility of software an alternative compatible programming software and interfacing accessories, compatible with the product on offer shall be provided, accompanied by the relevant training and skills transfer.

The Contractor shall provide his own computer hardware for programming, testing and commissioning of PLC's. The Contractor may receive, free issue for the duration of the contract, copies of the abovementioned software that he may utilise to program the proposed PLC. This software is issued on the condition that it is only utilised for this contract, may not be copied in any form and shall be returned, complete, to this Administration upon practical completion of the contract, with all installed software removed from development and programming computers.

All PLC programs shall be stored on usb flash drives, from which it shall be possible to download onto the PLC on site by means of a Notebook PC. "Master" and "Back-up" usb flash drives of all programs shall be issued to the Employer after commissioning. In addition to the usb flash drives, a hard copy (printout) of all software shall be provided with the manual.

No special passwords, dongles, or other protection shall be installed or copyrighted which may inhibit access to the software by Council's technical personnel. Where disputes of intellectual property may arise the contractor shall notify the City of Cape Town at tender stage so that the impact can be taken into consideration. The City of Cape Town may approve software deemed as intellectual property on the basis that the software is still accessible to fault find, based on an agreement that it may not be copied or re distributed.

25.4 DATA COMMUNICATION

The PLC's shall be able to interface with a ACE RTU device (provided at a future date where applicable by the City of Cape Town Administration and general plant equipment. The PLC shall be able to interface with the general plant equipment as well as a future SCADA network via a Modbus TCP/IP communications network.

If communication is required between PLC's this shall be achieved using" Ethernet" concept. .

PLC INPUTS / OUTPUTS

Although an Input / Output (I/O) schedule may be provided in the document, this indicates the minimum signals to be accommodated. The onus is on the Tenderer to study the proposed control of the philosophy and thus determine the precise I/O requirements and provide the necessary I/O's with spare allowance as per the requirements set out in the tender document.



25.5 **INSTALLATION**

The PLC shall be installed in the PLC and Instrumentation panel in the MCC room (within a separate tier or within the marshalling section in the MCC is preferred). The I/O's shall be wired to terminal blocks in the marshalling section of the PLC panel.

The PLC and Instrumentation panel manufacturer shall adhere strictly to the recommended mounting and earthing requirements of the PLC manufacturer. The panel manufacturer shall confirm to the Engineer that the PLC will not operate at any time outside the environmental limits published by the manufacturer. The average maximum and minimum temperatures, the humidity as well as the heat dissipation of the PLC shall be taken into consideration when designing the compartment housing and apparatus.

If forced ventilation and/or panel heaters are required to provide the climate necessary for the PLC apparatus, then this shall be included in the panel design, together with the climate monitors to inform the operator in the control room when the equipment is operating in undesirable conditions. Detectors shall be provided and wired to an input card of the local PLC to alert the operator via the alarm panel if the "climate" drifts outside the pre-set values.

25.5.1 **Monitors can have a typical specification of:**

Aspect Ratio	16:9
Panel Type:	In-Plane switching Technology
Maximum Pre-set Resolution:	3840 x 2160 at 60 Hz
Viewing Angle:	178° (vertical) typical
	178° (horizontal) typical
Pixel Pitch:	0.182 mm x 0.182 mm
Pixel Per Inch (PPI):	140
Contrast Ratio:	1300 : 1 (typical)
Backlight Technology:	LED edge light system
Brightness:	400 cd/m² (typical)
Adjustability:	Height adjustable stand (150 mm)
	Tilt (-5° to 21°)
	Swivel (-30° to 30°)
	Pivot (-90° to 90°)
Response Time:	8 ms (normal) ; 5 ms (Fast) - (gray to gray)
Flat Panel Mount Interface:	VESA (100 mm x 100mm)
Display Screen Coating:	Antiglare with 3H hardness
Preference:	Dell or similar
KVM with foldable screen rack mount	

26 SPECIALISED PROCESS CONROL SYSTEMS (SPCS) SECTION

26.1 Table of Abbreviations

Abbreviation	Definition
OWNER	City of Cape Town
CONTRACTOR	Company that is contracted to provide the SCADA services
ENGINEER	Contractor's appointee/employee
SCADA	Supervisory Control And Data Acquisition
PLC	Programmable Logic Controller
HMI	Human Machine Interface
I/O	Input / Output
RTU	Remote Terminal Unit
UPS	Uninterruptible Power Supply
NTP	Network Time Protocol
OEM	Original Equipment Manufacturer
SP	Single Point signal
MMI	Man Machine Interface
OAD	Operation Availability Demonstration
IP	Internet Protocol
PID	Proportional Integral Derivative
AC	Alternating Current
DC	Direct Current
O & M	Operations and Maintenance
UI	User Interface
OS	Operating System

26.2 GENERAL REQUIREMENTS

26.2.1 PART 1 - GENERAL

26.2.2 SCOPE OF WORK

CONTRACTOR shall provide all labour, materials, equipment as specified and required to furnish, install, configure, test, start-up and place in satisfactory operation a complete SCADA System.

SCADA System shall be designed to control, monitor, store, display and log process and equipment operating information and to perform various process control functions and generate various reports. The unit processes, which the SCADA shall monitor, and control are shown and described herein.

26.2.3 QUALITY ASSURANCE

General:

The SCADA System shall be furnished by a single Contractor who shall assume responsibility for providing a complete and integrated system.

a) All equipment, components and materials required shall be furnished by the single Contractor who shall assume the responsibility for adequacy and performance of all items.

b) Contractor's Qualifications: Contractor shall;

c) Be a financially sound company having at least more than five years' of continuous experience in designing, implementing, supplying and supporting instrumentation and control systems that are comparable to the SCADA System in terms of hardware, software, cost and complexity.

d) Have an experienced engineering and technical staff capable of designing, implementing, supplying and supporting the SCADA System and handling the SCADA System submittal and training requirements.

e) Provide system hardware components (where applicable) and software packages of fully developed, and field proven standardized designs.

f) Provide standard course offerings in general process control applications and in operation, programming and maintenance of the control system and equipment at a facility specifically utilized for training purposes. The facility shall have been in operation continuously for the last two years.

g) Have a thorough working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.

h) Have a demonstrated record of prompt response to field failures.

i) Have a documented program of failure analysis.

j) Experience:

k) Provide evidence of compliance with the specific experience requirements listed in Paragraph 1.2.B, above, in the form of an experience certification signed by an officer of the company.

l) Describe at least three completed municipal projects utilizing instrumentation and control equipment identical to or similar to (indicate which) that specified. Indicate owner, value, completion date, names and phone numbers of owner's representatives familiar with each project. Letters of recommendation may be submitted.

m) Furnish list of last ten projects completed.

n) Personnel: Provide a listing of those personnel committed to be assigned to the Project. List shall include Project Manager, Project Engineer, Field Representative. Provide documentation including resumes of personnel demonstrating experience in wastewater treatment applications.

o) SCADA Hardware and Software:

p) Provide a general system configuration drawing and types of the proposed SCADA System and all other proposed system components.

q) Provide descriptive literature and manufacturer's catalog information covering all aspects of the hardware design, functions and capabilities of the specific system proposed for the SCADA System.

r) Describe standard software packages proposed, including any customized software required to meet the functional intent of the system specifications. Descriptions shall address the following:

s) Overview of system software including the functions, organization and interrelationship of the major software modules provided.



t) Examples of graphic displays, methods of display access and procedures for display definition and generation, including use of the standard symbols library and capabilities for generating and storing user defined symbols in the symbol library.

u) Real-time data logging and reporting software features and capabilities including examples of logs and reports, procedures for automatic reporting and logging file setups, limitations on sampling and computing frequency for data acquisition and logging, and utilities for log file and report modifications and file maintenance.

v) Alarm handling software features and capabilities including an alarm display example, methods of defining alarms and alarm files, automatic printing of alarms, acknowledgements and return to normal conditions, chronological sorting and time-tagging of alarms, and alarm file maintenance utilities.

w) Training: Provide information about the factory facilities to be utilized for the training specified. Indicate the qualifications of the factory training staff.

x) Start-Up and Field Testing: Indicate how the Availability Demonstration will be accomplished.

26.2.4 COORDINATION AND PROGRESS MEETINGS

CONTRACTOR shall be responsible for scheduling and coordinating the system installation with regard to all other Work on the Site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the Project Schedule.

Routine progress and coordination meetings will be scheduled by ENGINEER. CONTRACTOR and a minimum of 2 meetings each month.

The purpose of the meetings shall be to review the progress of the Work involving the SCADA System and provide coordination for installation of the equipment to ensure Project Schedule is met and to minimize disruption of current plant operations.

Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit CONTRACTOR and OWNER to agreed procedures and schedules.

26.2.5 SCADA SYSTEM CONTRACTOR'S PROJECT PERSONNEL

CONTRACTOR shall be required to provide the following project personnel:

Project Manager:

a) The Contractor shall appoint a Project Manager who shall coordinate and schedule all the Work and assure that the Project Schedule is met.

b) The Project Manager shall act as the liaison with CONTRACTOR for the installation of the SCADA System equipment and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.

Field Engineer:

The CONTRACTOR shall appoint an ENGINEER with responsibilities as follows:

a) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.

b) Installed system checkout, calibration, adjustment and start-up including tuning of every control loop.

c) Maintenance services during availability demonstration.

d) Involvement in the on-site system training of plant personnel.

e) Resolving of control problems encountered during initial start-up and testing of all SCADA System equipment.

f) The Field Engineer shall have a minimum of five years' experience in systems engineering and start-up and shall have a thorough working knowledge of both the hardware and software supplied for the SCADA System.

[redacted]

26.2.6 SUBMITTALS

Drawings:

General:

a) Drawing submittals shall be in accordance with the requirements of the Contract Documents.
b) Drawings shall be submitted in complete packages grouped to permit review of related items.
c) Review of Drawings will be for conformance with Contract Documents and with regard to functions specified to be provided.
d) Final and approved copies of all Drawings shall be provided in AutoCAD format on a CD-ROM or in USB Flash-drive.
e) Submittal Requirements:
f) Product information for all sensors/transducers and field and panel instruments. Specification Forms for Process Measurement and Control Instruments, Primary Elements and Valves, include the following:
g) Manufacturer's product name, serial number and model number.
h) Instrument tag number from Contract Documents.
i) Manufacturer's standard catalog product data.
j) Description of construction features.
k) Performance and operation data.
l) Installation and mounting details, instructions and recommendations.
m) Service requirements.
n) Dimensions.
o) Range of each device and calibration information

26.2.7 .SCADA System Information:

System Description:

a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
b) Software language and organization.
c) Format, protocol and procedures for data highway communications and local communications with input/ output modules and peripheral devices.
d) Control and failure modes.
e) On-line and off-line capabilities for programming, system utilities and diagnostics.
f) Input/output point listing with I/O module cross-reference identification for each distributed controller.
g) Data base listing including all input/output points.
h) Suggested detailed format and configuration of all log reports, alarm summaries, printer outputs, screen displays and graphics.

Equipment Hardware:

i) Layout drawings showing front, rear, end and plan views to scale of all processing equipment, I/O components, power supplies and peripheral devices.
j) Construction details, features and procedures.
k) Interconnection diagrams including termination details, cable identification list and cable length.
l) Plans showing equipment layout in control panels.
m) Installation requirements, instructions and/or recommendations.
n) Software Description:
o) Standard technical documentation covering all aspects of the distributed control system software functions and capabilities, including instruction set description and programming procedures related to control, monitoring, display, logging, reporting and alarming functions.
o) (i) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions.

[redacted]

o) (ii) Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.

o) (iii) Documentation describing central monitoring station main and secondary memory types, size and requirements to perform the display, logging, reporting and alarming functions required.

26.2.7.1 **Reports:**

a) Two copies of the following reports shall be submitted to OWNER:

b) Factory Test Reports

c) Installation Inspection, Field Calibration, and Field Testing Reports

26.2.7.2 **System Designs:**

a) Range scale and set point values specified for initial setting and configuration. Coordinate to these values with actual equipment furnished to implement proper and stable process action as systems are placed in operation.

b) For any items where ranges scales and set points may not have been specified CONTRACTOR shall submit a recommendation to OWNER for review.

[redacted]

26.3 SCADA CONFIGURATION

26.3.1 SCOPE OF WORK

a) The latest version of web-based **SCADA** Software (HTML-5 or latest) suite shall be used.
b) The SCADA shall run on the latest Windows Server OS. or Latest Microsoft Windows professional platform and or Linux for remote maintenance (project specific)
c) The SCADA license shall follow software license types, each installed on its own Server, Windows PC, laptop or panel PC
d) The software license shall allow for sufficient number of clients, tags, and connections based on project specific requirements.
e) The SCADA software shall come with the standard comprehensive set of data acquisition tools which includes built-in OPC UA/MQTT and drivers (Modbus TCP/IP/Ethernet/EtherNet IP/Profibus/ProfiNet) to connect to practically any PLC. For special needs and with approval of CCT engineer the SCADA shall allow for interface to Modbus plus networks.
f) Shall have the ability to seamlessly connect to any SQL or no-SQL databases.
g) Any middleware software shall reside on the City of Cape Town Hardware
h) A **standalone** topology shall be provided for smaller plants and main and hot standby topology or Cluster for the larger plants. Hot Standby/Cluster topology, shall be used with automatic changeover should the "main" SCADA machine fail. Automatic data restoration shall be performed once "main" SCADA machine has been returned to service.
i) Larger plants shall be classified at project stage by the CCT Engineer.
j) The computer naming convention will be as follows (X refers to the specific Plant and will be defined at Project stage by CCT engineer):

26.3.2 SCADA server 1

Computer name:	Scada1
IP address:	172.27. X.6
Subnet	255.255.255.0
Gateway	172.27. X.1
Administrator account:	user name
	password
Auto-boot account:	user name
	password
Workgroup:	SCADA

[redacted]

26.3.3 SCADA server 2

Computer name:	scada2
IP address:	172.27. X.7
Subnet	255.255.255.0
Gateway	172.27. X.1
Administrator account:	user name
	password
Auto-boot account:	user name
	password
Workgroup:	SCADA

[redacted]

26.3.4 DATABASE server

Computer name:

IP address:
Subnet

[redacted]

[redacted]

Gateway	172.27. X.1
Administrator account:	user name
.	password
Auto-boot account:	user name
.	password
Workgroup:	SCADA



26.3.5 Workstation

Computer name:	scada3
IP address:	172.27. X.9
Subnet	255.255.255.0
Gateway	172.27. X.1
Administrator account:	Username
	Password
Auto-boot account:	Username
	Password
Workgroup:	SCADA



26.3.5.1 Graphical Presentation/Dashboard

a) There shall be an overview graphic page, which depicts all functions or processes on the plant in block form.
b) Background colour shall be white, UNLESS otherwise specified by the Plant.
c) The background templates to give applications a consistent and professional look and feel.
c) (i) Import PNG, BMP, JPG, WMF and EMF
c) (ii) Import backgrounds, maps, watermarks
c) (iii) Add 3D graphics created with 3rd party software (Must be flat jpg, png, bmp)
c) (iv, The graphics or images shall be in a SVG (Scalable Vector Graphics) format
d) A graphic page must depict a common segment of the process or operational area.
e) All graphic page should have a "title" bar at the top which displays:
e) (i) Left; the menu button
e) (ii) Left of Center, an indication of unacknowledged alarms.
e) (iii, Center; The name of the mimic, which describes the process area depicted by the mimic.
e) (iv, Right; Date and Time in the format YYYY/MM/DD HH:MM: SS
f) When an analogue signal is out of range the mimic should replace the value with "trans fail"
g) Tenderers shall allow for at least 4 re-iterations of the mimic designs as there will be amendments and comments during inspection and testing by the client and the Engineer as well as operational staff during commissioning.
h) When an analog signal is greater than the alarm limit set point the displayed value will alternate between the actual value and a Red "High "
i) When an analog signal is smaller than the alarm limit set point the displayed value will alternate between the actual value and a Red "Low "

26.3.5.2 Colour Coding and symbols

Shall as possible reflect the IEC standards for Process and Instrumentation Diagrams; (**Annexure 1**) . Allowance shall be made for Prj specific requirements, to be approved by CCT Engineer.

26.3.5.3 Process Flow Graphics

a) Dashboards shall be configured to represent process flow as accurately as possible using IEC standards or CCT Engineer approved symbols



b) Dashboards shall be displayed in 16 million colours and on maximum screen resolution of 1024x768 pixels

c) Dashboards load time/refresh rate, from the selection on "Menu" or "Overview" Dashboards to completely loaded and dynamisized, shall not exceed 3 seconds

d) All Dashboards shall conform to the Standard screen layout and label font sizes shall be standardized throughout. Not font smaller than 10 points (pt) shall be used

26.3.5.4 Equipment Display Faceplates

a) All Operating equipment such as Motors, Actuators, measured values and Controllers shall be represented by standard display faceplate

b) Faceplates may be customized for specialized equipment only as agreed by the client (Plant)

c) Faceplates shall clearly identify the operated equipment by its TAG Description and clearly display equipment status, Start/Stop, Auto/Man and reset commands in a common colour & common font

26.3.5.5 Navigation

Auto-generated SCADA Page Navigation

Easily move through the entire application using the Main Menu at the top left corner of every page. When you create a new application, all standard system pages like trends and alarm management shall be automatically added.

Tiled Page Menu

Operators can easily oversee multiple displays at once using this intuitive visual interface. Each tile re-sizes to fit displays at the chosen menu level. Large tiles display live process data while smaller ones are thumbnails. Click tiles to open pages or sub-folders. See recently viewed pages across the top. Easily access the Tiled Page View page using an icon in the top corner of every page. The Tiled Page View page is generated based on the Main Menu.

Easy Menu Customization

Main Menu and Tiled Page Menu items are stored as nested tags in the Browser. There you can easily add, remove, or re-order your application pages with just a few clicks.

Browser-like Navigation

Familiar forward and back buttons in the top right corner of every page move you through recently visited pages.

Pin Favourite Pages

The users must pin their most visited pages to the bottom of every application screen. These sets of pins are associated with the operator's application security account and are available where ever they log into the application.

Custom Navigation Tools

Developers can configure hotboxes and buttons to provide navigation from any custom display page.

26.3.5.6 Alarms

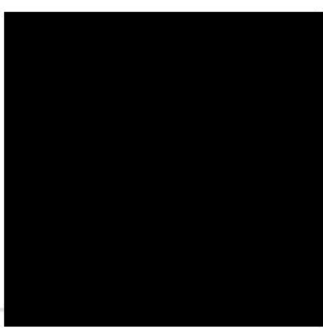
a) A full alarm listing window is available via the ***"Alarms"*** button located on the bottom menu bar.

b) Alarms should be associated with process mimics.

c) Alarm description must be understandable.

d) The general alarms window, accessible from the overview mimic, should only contain alarms NOT displayed in other alarm windows.

e) The Alarm window should display



Date	(YYYY/MM/DD),
Time (HH:MM: SS)	24-hour format,
Description	(from the agent);
Alarm type	(from the agent),
Reported Data	(from the agent).

Must display a title bar with the function to close the window.

26.3.5.7 **Trends/Graphs**

a) Trends should be associated with process graphic pages.
b) Up to 4 trend values should be displayed on one window and only in exceptional cases can this be expanded to a maximum of 6 values.
c) Trended values should be vertically separated within a trend window unless specifically indicated otherwise such as P.I.D values.
d) Trended values should be displayed on a trend window with a 24-hour time scale with a 10 second resolution. The period type should be current – interval. The Labels should be at 6 hour intervals on a 1-hour grid.
e) Trended values should also be displayed on a trend window with a 30-day time scale with a 300 second (5 minute) resolution. The period type should be current – interval. The Labels should be at 7 day intervals on a 1-day grid.
f) Must display a title bar with the function to close the window.

26.3.5.8 **Logging**

a) Data should be logged to the SCADA's proprietary database, SCADA logged values, and to a Squeal database.
b) SCADA logged values should be grouped together in the same manner as for trend windows and save in a separate log file per group.
c) The SCADA log files should have a same name to that of the trend window.
d) Each SCADA log value shall be logged for 60 days with a 5 second resolution.
e) The file should be overwritten on a First in, First Out (FIFO) bases thus always holding the most recent 60 days of data.
f) A batch file initiated from a button a dashboard should archive the SCADA log files to an archive folder on the SCADA machine.
g) A separate SCADA machine connected at the Ethernet layer should be used to warehouse the Squeal database.
h) Each SQL log value shall be logged for 3 years with a 15 minutes' resolution.

26.3.5.9 **Events**

a) The events log should be able to contain 1000 records
b) The events log must automatically be backed up to the events archive folder at 23:55 with filename + date
c) The Event window should display

Date	(YYYY/MM/DD),
Time (HH:MM: SS)	24-hour format,
Description	(from the agent);
Action	
Alarm type	(from the agent),
Reported Data	(from the agent).



Category

26.3.5.10 Set-point Entry

a) There will be 3 levels of set points
a) (i) Operational Set points accessible by operational staff (see security Section U)
a) (ii) Critical Set Points – accessible by supervisors (see security Section U)
a) (iii) System Set Points - accessible by admin/technical staff (see security section U)
b) All set point entry shall be password protected such that the relevant person must reenter his/her password even when logged on to change a set point.
c) A set point entry must be limited to the specified range.

26.3.5.11 SCADA Diagnostics

a) The SCADA System shall have full diagnostic graphic page for the First Line Maintenance not limited to the following;
a) (i) Start-up sequences
a) (ii) Process Monitoring (Filters, Valves)
a) (iii) Condition Monitoring
a) (iv) PLC Network overview

26.3.5.12 Security Configuration

a) Groups shall be created to contain the various categories of users that you need to create. These can usually be defined by the task that they perform and the following group names shall be used as follows:
a) (i) **Operators:** Process Controllers, but with access to operator actions and execute commands and possibly extended menu capability
a) (ii) **Supervisors:** Managers and Supervisors, with full menu capability and full access to SCADA configurations for creating and editing.
a) (iii) **Administrators:** Process Control Systems staff with full access to Windows but has extra power in Dashboards interaction and capability to disable the overriding power of the standard Windows Administrators group.
b) Note: Plant area groups can shall also be created per plant area, if necessary, to disallow operators from one plant area operating in other plant areas.

26.3.5.13 Security on Operation

a) The SCADA Software shall be secured, built on a solid, unified architecture and proven, industrial-grade security technology.
b) The security shall supports the secure communication for the seamless integration with existing security systems.
c) The SCADA software shall support modern, web-based authentication such as federated identity, multi-factor authentication (MFA), and single sign-on (SSO)
d) To assign user roles natively or to integrate with corporate network security using Microsoft Active Directory

SCADA Security				
Start Up		Operators	Supervisors	Administrators
1	When the system boots up the Overview Dash board shall start as a Windows service.	Move from dashboard to dashboard	Move from dashboard to dashboard	Move from dashboard to dashboard
2	The Overview dashboard shall automatically start.	Move to any trend view.	Move to any trend view.	Move to any trend view.

[redacted]

3	After startup the overview only graphic shall be displayed. This will force the process controller or manager to logon so a trace of all users can be kept.	Stop, start and all equipment.	Stop, start and all equipment.	Stop, start and all equipment.
4	All SCADA menu items will be **inaccessible**.	Display alarm lists and Acknowledge all alarms.	Display alarm lists and Acknowledge all alarms.	Display alarm lists and Acknowledge all alarms.
5	All Windows operations shall be inaccessible. The Task Manager shall not be accessible from the keyboard. The Explorer shall **not be accessible**.	Changing of all values or set points must be **denied.**	Changing of all values or set points must be **available.**	Changing of all values or set points must be **available.**
6	Windows shall not be able to be shutdown.	All SCADA configuration menu items shall be **inaccessible.**	All SCADA configuration menu items shall be **inaccessible.**	All SCADA configuration menu items shall be **accessible.**
7	Operation of the USB port and the CD ROM drive shall be disabled.	All Windows operations shall be **inaccessible**. The Task Manager shall **not be accessible** from the keyboard. The Explorer shall **not be accessible.**	All Windows operations shall be **inaccessible.** The Task Manager shall **not be accessible** from the keyboard. The Explorer shall **not be accessible.**	All Windows operations shall be **accessible**. The Task Manager shall **not be accessible** from the keyboard. The Explorer **shall be accessible** through the *system* mimic.
8		Windows **shall not be able** to be shutdown.	Windows **shall not be able** to be shutdown.	Windows **shall be able** to be shutdown.
9		Operation of the USB port and the CD ROM drive shall be **disabled.**	Operation of the USB port and the CD ROM drive shall be **disabled.**	Operation of the USB port and the CD ROM drive shall be **enabled.**
10				A graphic page **shall be available** with buttons for easy access to the following: Windows Task Manager. Windows Explorer. Windows User Manager.

[redacted]

26.4 FACTORY TESTING

26.4.1 PART 1 - GENERAL

26.4.2 SCOPE

a) CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform factory testing, before shipment, at the manufacturer's facility to verify that system components are functioning properly and that they meet the functional and performance requirements of the Contract Documents. The system includes, but is not necessarily limited to, the following major equipment.

b) CONTRACTOR shall submit information on factory testing procedures to verify that testing shall fulfill the requirements as specified herein. Submittal to ENGINEER shall be made at least two months in advance of any scheduled testing and shall include dates of scheduled tests.

c) CONTRACTOR shall notify ENGINEER, in writing, at least four weeks before expected initiation of tests. OWNER and ENGINEER may elect to be present at CONTRACTOR'S facilities during operational test of system equipment, either for individual units or as an integrated system. Presence of OWNER and ENGINEER during testing does not relieve CONTRACTOR from conforming to the requirements of the Contract Documents and shall in no way imply acceptance of the equipment.

d) Factory Testing shall not begin until all related SCADA System shop drawings have been submitted and approved.

e) CONTRACTOR shall be responsible for the expenses associated with 5 of the OWNER's representatives attending the Factory Acceptance Test (IF out of Cape Town or Country).

26.4.3 INSPECTION

a) All panels, consoles and cabinets shall be inspected. Inspection shall include, but not be limited to, the following:

a) (i) Nameplates and tags.

a) (ii) Wire sizes and colour coding.

a) (iii) Terminal block contact ratings and numbers.

a) (iv) Annunciator and terminal block spares.

a) (v) Proper wiring practices and grounding.

a) (vi) Enclosure flatness, finish and colour.

26.4.4 SYSTEM HARDWARE OPERATIONAL TESTING

a) All input/output devices and components shall be tested to verify operability and basic calibration.

b) All system hardware components shall be tested to verify proper operation of the equipment as standalone units. Tests shall include, but not be limited to, the following:

b) (i) AC/DC power checks.

b) (ii) Power fail/restart tests.

b) (iii) Diagnostics checks.

b) (iv) Test demonstrating that all specified equipment functional capabilities are working properly.

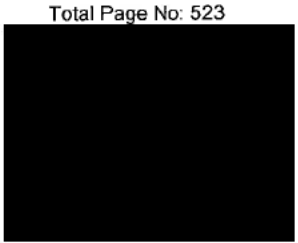
c) All PLC input/output devices shall be tested to verify proper operation and basic calibration. CONTRACTOR shall test all input and output points prior to the witnessed factory test and shall provide copies of signed and certified check lists or other documentation to demonstrate the completion of I/O testing. A random sampling of I/O (both digital and analog), in an amount approximately equal to five percent of the total I/O count, shall be selected by ENGINEER and tested during the witnessed factory test.

d) PLC I/O testing shall include, as a minimum, the following:

d) (i) Simulate a field digital input for each PLC input point at the terminal strip of the control panel and verify PLC response.

d) (ii) Simulate a field analog input for each PLC analog input point at the terminal strip of the control panel and verify PLC response.

d) (iii) Force an output for each PLC digital output point and verify the signal presence at the terminal strip in the control panel.



d) (iv) Simulate an analog output for each PLC analog output point and verify signal presence at the terminal strip in the control panel.

e) All system components shall be tested to verify that communication between units is working properly.

f) An integrated system test with all system equipment connected (excluding field sensors and instruments) shall be performed to verify that all equipment is performing properly as an integrated system.

26.4.5 SYSTEM SOFTWARE DEMONSTRATION

CONTRACTOR shall demonstrate all system software utility and security programs incorporated into the system to illustrate the various functions and capabilities specified.

CONTRACTOR shall demonstrate the operation and display of all software based on a simulation of five percent of total input/output count, both analog and discrete, as selected by the manufacturer. In addition, OWNER/ENGINEER shall randomly select, at the time of the test, additional inputs and outputs to be simulated in an amount approximately equal to five percent of total input/output count. Demonstration shall show that the monitoring and control application software associated with the input/output points performs the functions intended.

System performance shall be tested using a fully integrated system, including all software and hardware if applicable. To achieve this, the entire control system, including all the peripheral devices and all interconnecting cables, shall be assembled on the factory test floor and simulated inputs applied. CONTRACTOR shall carry out a full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. CONTRACTOR shall provide process I/O simulation panel prior to the test:

a) Toggle switches to simulate field or other input contacts.

b) Indicating lights to simulate outputs from tested panels.

c) Control relays to simulate MCC coil inputs.

d) Time relays to simulate position switches.

e) Indications (mA) to indicate every 4 to 20 mA/DC output from tested panel.

f) Potentiometers to simulate 4 to 20 mA/DC inputs to tested panel.

g) Every device shall have a nameplate containing the device under test's P&ID tag number and description. Nameplates shall be removable and interchangeable for reuse of the I/O simulator panel during the progression of the testing.

g) (i) Demonstration of communication between processors or to remote I/O units shall be included in the Test Procedure, where applicable.

g) (ii) Operator Interfaces: Prior to the staging and testing of the system, the display environments shall have been configured in accordance with the agreed upon display structure, loaded and data base parameters linked to the specified fields. During this phase of the factory acceptance test, the overall display structure shall be demonstrated, including environment configurations, passwords, security, etc. The memo display contents shall be reviewed to demonstrate how an operator navigates within the overall display structure. The assignment of displays to annunciator keys shall also be demonstrated. Each graphic display shall be reviewed for correctness in terms of the layout, symbols, colour scheme, etc. The operation of standard alarm management displays (Current Alarm Display, Alarm History, etc.) shall also be demonstrated. A demonstration of each type of report specified shall be performed. Printing shall be an integral part of the report demonstration.

[redacted]

26.5 START-UP & FIELD TESTING

26.5.1 PART 1 - GENERAL

26.5.2 SYSTEM CHECK-OUT AND START-UP RESPONSIBILITIES

a) CONTRACTOR shall provide all labour, materials, equipment as specified and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment.

b) CONTRACTOR shall perform check-out and start-up of all system components. As part of these services, check the equipment installation and place the equipment in operation.

26.5.3 SYSTEM CHECKOUT AND START-UP

a) CONTRACTOR, under the supervision of the OWNER, shall perform the following:

a) (i) Check and approve the installation of all SCADA System components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.

a) (ii) Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this work, they should be included in the system checkout. All problems encountered shall be documented and promptly corrected to prevent any delays in start-up of the various unit processes.

b) CONTRACTOR shall provide all test equipment and software necessary to perform the testing during system checkout and start-up. CONTRACTOR shall transfer all test equipment and software to the OWNER after all final testing and commissioning.

c) CONTRACTOR shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.

d) CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and devices.

e) CONTRACTOR shall furnish ENGINEER an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the OWNER.

f) CONTRACTOR shall provide all software and licenses required to operate, troubleshoot, maintain and repair all systems provided under this contract.

26.5.4 INTEGRATED SYSTEM FIELD TEST

a) Following the SCADA System checkout and initial operation, CONTRACTOR, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by CONTRACTOR and then retested to demonstrate proper operation



26.6 TRAINING

26.6.1 PART 1 - GENERAL

26.6.2 REQUIREMENTS AND RESPONSIBILITIES

a) CONTRACTOR shall provide all labour, materials, equipment as specified and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER. No part of the training shall be construed as a substitution for complete and comprehensive Operations and Maintenance (O&M) manuals, but should follow the same organizational structure as the O&M manuals.

b) CONTRACTOR shall provide operation and maintenance training for all SCADA equipment as specified herein.

c) All training shall be conducted to meet the needs of the OWNER personnel during all shifts. For training at the Contractor's facility, the course instructor shall be assigned full time and shall not perform other duties throughout the period of the course

26.6.3 TRAINING AT THE CONTRACTOR'S FACILITY

a) General:

b) CONTRACTOR shall provide a standardized, structured training at an established training facility, covering both operation and maintenance of the system equipment

c) All training shall be scheduled so that it has been completed prior to the start of the factory testing of the system.

d) OWNER will send the following personnel to attend training courses at the CONTRACTOR's facilities.

d) (i) SCADA Systems Training: 5 persons.

d) (ii) SCADA System Maintenance Training: 5 persons.

26.6.4 ON-SITE TRAINING

a) SCADA Training:
The CONTRACTOR shall provide training that covers SCADA Configuration, Start-up and Field Testing Sections as follows:

a) (i) Provide an overview of system hardware and software.

a) (ii) It shall train people in configuration, operation and programming processors.

a) (iii, The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.

a) (iv, Instruction for hardware and software maintenance, trouble shooting and maintenance planning.

Provide an overview of system hardware and software.

It shall train people in configuration, operation and programming processors.

The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.

Instruction for hardware and software maintenance, trouble shooting and maintenance planning.

a) Computer Hardware and Software:
Training prior to Operation Availability Demonstration (OAD):

a) (i) Provide two days of operations training covering all system components prior to the start of the OAD.

a) (ii) Training course shall accomplish the following:

- Overview of systems functional capabilities.
- Equipment overview including system component functions, operating principals and proper use.
- Loading and start-up of the digital system hardware components.
- Use of system commands.

- Use of storage device for system backup.
- Description of the maintenance and troubleshooting aids of the system, including software diagnostic programs.
- Description of peripheral and other connected devices.

a) (iii) Personnel attending the training shall be capable of assuming the position of system operator during the OAD.

b) SCADA System Maintenance Training Course

Provide a 5 days, eight hours per day, course covering preventive and troubleshooting maintenance for the system components. The course shall familiarize the student with diagnostic capabilities of the system, both software and hardware, and also the routine maintenance procedures on the system and the common peripheral devices.

As a minimum the course shall cover the following topics:

b) (i) System overview description including the power subsystems and logic components of the processor bus.

b) (ii) Description of the maintenance and troubleshooting aids of the system including software diagnostic programs.

b) (iii) Description of all bus operations.

b) (iv) Description of peripheral and process interface devices.

b) (v) Development of programs and control schemes.

b) (vi) Development and use of system displays.

b) (vii) Programming concepts and techniques.

b) (viii) Use of storage devices for system backup

[redacted]

26.7 COMPUTER NETWORKS

26.7.1 PART 1 - GENERAL

26.7.2 DESCRIPTION

a) Scope:
CONTRACTOR shall provide all labour, materials, equipment as specified, and required to furnish, install, test, start up, and place in satisfactory operation complete SCADA computers and computer network. System shall be as specified in the applicable Specifications and as shown. System includes the following equipment:

a) (i) Engineering Workstation computer

a) (ii) SCADA servers

a) (iii) Historian/Database server

a) (iv) Network Switches and Routers

SCADA computers and computer network shall allow computers to share data and use common equipment, such as printers and servers.

The configuration and addressing of all new network switches and routers shall be performed by the OWNER

The CONTRACTOR shall be responsible for the SCADA computers and computer network as follows.

a) Designing, fabricating, and implementing of SCADA computers and computer network and all subsystems in accordance with the Contract Documents.

b) Preparing, assembling, and correcting all SCADA computers and computer network submittals in accordance with the Contract Documents.

c) Proper interfacing of SCADA computers and computer network hardware and software.

d) Supervising installation of SCADA computers and computer network.

e) Testing and start-up of SCADA computers and computer network.

f) Training of OWNER's personnel in operating and maintaining SCADA computers and computer network.

26.7.3 QUALITY ASSURANCE

a) Comply with the requirements of General Requirements.

b) All cabinets and panels for the Computers and Networks equipment shall be constructed as per SPCS Standards

26.7.4 SUBMITTALS

a) Action Submittals: Submit the following:
Drawings

a) (i) Drawings of proposed layout of computer network and communications, showing computers, related equipment in relation to each other and the following is the Standard SCADA/PLC Network diagram:

a) (ii) The architecture shall, prior the implementation to be signed by PCS and D&C

b) Product Data:

b) (i) Manufacturer literature containing product name and model number.

b) (ii) Manufacturer standard catalog data for materials and equipment proposed.

b) (iii) Description of construction features.

b) (iv) Dimensions and weights.
Informational Submittals: Submit the following:

c) CONTRACTOR shall coordinate with the SPCS section for the latest standards for server, computer and network equipment.

d) Reports:

d) (i) Four copies of the following reports shall be submitted to OWNER:



- Factory Test Reports after commissioning,
- Installation Inspection, and Field Testing Reports after commissioning

e) Manufacturer's Instructions:

e) (i) Installation and mounting details, instructions, and recommendations.

e) (ii) Service requirements.

f) Closeout Submittals: Submit the following:

f) (i) Operations and Maintenance Data: Furnish operation and maintenance manuals for SCADA computers and computer network

26.7.5 **2.2 SCADA WORKSTATION**

a) General:

a) (i) SCADA Workstations shall be utilized as the human-machine interface

a) (ii) All SCADA Workstations shall be functionally interchangeable differing only in the network address. Each Workstation's functional environment shall be password protected for system security and user identification. Required number of SCADA Workstations shall be provided as shown.

a) (iii) Each SCADA Workstation shall include a high-resolution flat panel LCD display designed for continuous operation and use in conjunction with the Workstation modules.

a) (iv) Local controls shall be provided with each LCD monitor for contrast, brightness, tint, and focus. Radiation emission shall comply with existing industry standard requirements. The monitor shall have tilt and swivel base.

a) (v) The keyboard shall be laid out for ease of operation and shall contain English language keys for entering alphabetic, numerical, and functions for display and control purposes.

a) (vi) Provide equipment to operate on 220 VAC, single phase, 50-hertz electrical service.

a) (vii) Provide all necessary items for installation, including mounting brackets, interconnecting cables, hardware and appurtenances.

[redacted]

SCADA Workstation Hardware:

b) Each SCADA Workstation shall consist of individual Workstation electronics (e.g., Workstation electronics shall NOT be shared amongst more than one Display Workstation) to support one high resolution flat panel LCD display, data highway communications and utilize a password-protected resource configuration environment for high level system and control configuration.

Performance	Chipset	Intel Celeron J1900/3865U/3855U/Core i3/i5/i7
	Memory	2GB DDR3, up to 8GB
	Storage	64GB SSD, up to 512GB Msata MLC SSD
	Hardware Monitor	Monitors voltage, CPU, TEMP
	Watchdog	0-255 sec by software
	OS	Windows and Linux OS
	Power Supply	9-24V DC IN
I/O	USB	J1900: 5*USB2.0+1*USB3.0
	COM	6*RS232 (1 or 2*RS485/RS422 optional)
	Ethernet	2*RJ45 GbE 1000M
	Audio	1*Line out+1*Mic
	Display	1*VGA+1*HDM1
	Mini PCIe	1*MiniPCIe for WiFI/BT/3G/4G option
Environment	Anti-Vibration	5-19Hz/1.0mm amplitude;19-200Hz/1.0g, acceleration
	Anti-shock	10g acceleration, 11ms duration
	IP level	Front panel IP65(optional)
	Reliability	MTBF≥5000h; MTTR≤0.5h
	Working Temp.:	-20℃--70℃ with air flow
	Storage Temp.:	-30℃ --80℃
	Working Humidity	95% @40℃, non-condensing
	Dimension	211.5mm(L)*200mm(W)*67mm(H)
	Installation	Put on desk or Stand for embedded installation
	Material	Fanless design, High-strength and elegant Al-alloy casing
	Weight	2.6kg/4.0kg(NET/Gross)
	Colour	Black
Warranty	1 year warranty with extended warranty option	

SCADA Workstation Software:

c) Microsoft Windows Professional, including latest Service Packs.
d) Microsoft Office Basic, latest version and service packs.
e) Anti-Virus Software from Sophus with minimum 1-year subscription.

26.7.6 SCADA SERVER

General:

f) SCADA Servers shall be utilized as the primary means of communication between the SCADA Workstations and field controllers as shown.
g) All SCADA Servers shall be functionally interchangeable differing only in the network address. Each Server's functional environment shall be password protected for system security and user identification. Required number of SCADA Servers shall be provided as shown.



h) Provide equipment to operate on 220 VAC, single phase, 50-hertz electrical service.

i) Provide all necessary items for installation, including mounting brackets, interconnecting cables, hardware and appurtenances.

SCADA Server Specifications:

Item	Requirement
Form Factor	Rack mount
U (Rack Units)	1U
CPU Size	Intel® Xeon® Silver 4310 2.1G, 12C/24T, 10.4GT/s, 18M Cache, Turbo, HT (120W) DDR4-2666 CPU - Max Qty: 2 Installed CPU Cores: 12
Memory Pre-Installed	2x 16GB RDIMM, 3200MT/s, Dual Rank Memory Slots - Max Qty: 16
Hard Drives Pre-installed	1.2TB Hard Drive SAS ISE 12Gbps 10k 512n 2.5in with 3.5in HYB CARR Hard Drive Bays - Max Qty: 4
Backplane	3.5" Chassis with up to 4 Hard Drives (SAS/SATA) 1 CPU
Optical Drive Pre-installed	None
Raid Controller	Front PERC H755 Front Load
Power Supply	Single, Hot-Plug, Power Supply (1+0), 600W Power Supplies - Max Qty: 2
Network	Broadcom 57412 Dual Port 10GbE SFP+, OCP NIC 3.0
Management	iDRAC9, Enterprise 15G
Warranty	3 Year Basic
Included with this Server	Ready Rails Sliding Rails Without Cable Management Arm

SCADA Server Software:

a) Latest Microsoft Windows Server, x64 Edition with Media Kit, including latest Service Packs and 5 CAL's.

b) Latest Linux server software- Licensed version

c) Anti-Virus Software with minimum 1-year subscription.

d) Server software shall be configured into existing SCADA domain.

26.7.7 ETHERNET LAYER 2 AND 3 SWITCHES AND ROUTERS

General:

a) Provide equipment to operate on 220 VAC, single phase, 50-hertz electrical service.

b) Provide all necessary items for 19" rack installation, including mounting brackets, interconnecting cables, hardware and appurtenances.

c) ANY configuration of the switches and routers provided by the CONTRACTOR will be performed by the CCT.

Ethernet Switch Specifications:

a) The Ethernet switch will be an Unmanaged, 24-port Switch

Features	
10/100/1000Mbps Ports	24
ENCLOSURE	Metal
CONNECTOR TYPE	Metal
PERFORMANCE	
Bandwidth	96 Gbps

[redacted]

Buffer Memory	1.5MB
Jumbo Frames	9.216 bytes
Forwarding Rate (using 64-byte packets)	1,448,000 pps
Latency (using 64-byte packets)	< 4 µsec
MAC Address Table Size	16K
FORM FACTOR	Desktop Rack-Mountable
ENERGY EFFICIENCY	
Energy Efficient Ethernet (EEE) IEEE 802.3az	Yes
Auto Power Down	Yes
Short Cable Detection	Yes
Power Supply	Internal (AC: 110-240V, 50-60Hz, 1.0A max)
Power Consumption (Max and Standby)	23.0W / 8.81W
Heat Dissipation (Max and Standby)	78.66 BTU / 33.13 BTU
PORT LEDS	Power, Link/Activity
DIAGNOSTICS	
Network management software (Licenced)	
PHYSICAL SPECIFICATIONS	
Width x Depth x Height	440 x 204 x 43.2 mm
Weight	3.15 kg
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	0° to 50°C
Storage Temperature	–20° to 70°C
Operating Humidity	90% maximum relative humidity, non-condensing
Storage Humidity	5% to 95% relative humidity
PROSUPPORT EXTENDED SUPPORT CONTRACTS	3-Year On Call 24x7 Support Plan

Firewall Router Specifications

Performance and Capacities Specifications	
Firewall throughput (App-ID)	2.1/2.1 Gbps
Threat prevention throughput	1.0/1.2 Gbps
IPSec VPN throughput	1.6 Gbps
New sessions per second	13,000
Max sessions	192,000
Hardware Specifications	
I/O	10/100/1000 (4), Gigabit SFP (8)
Management I/O	10/100/1000 out-of-band management port (1) 10/100/1000 high availability (2) RJ-45 console port (1) USB port (1) Micro USB console port (1)
Storage Capacity	240GB SSD
Power Supply	Fixed AC 200 W power supply (1)

[redacted]

Power Consumption	Maximum: 120 W Average: 41 W
Max BTU/hr	256
Input Voltage (Input Frequency)	100-240VAC (50Hz)
Max Current Consumption	1.0 A @ 100 VAC, 0.5 A @ 240 VAC
Max Inrush Current	0.4 A @ 230 VAC, 0.96 A @ 120 VAC
Rack Mountable	1U, 19" standard rack
Dimensions	1.75" H x 14" D x 17.125" W
Safety	cCSAus, CB
Environment	
Operating temperature	32° to 104° F, 0° to 40° C
Non-operating temperature	-4° to 158° F, -20° to 70° C

KVM (Keyboard Video Mouse) Extender Specifications:

SPECIFICATION	TRANSMITTER	RECEIVER
CONNECTORS	Host connection:	Console connection:
	Video Input: (1) HDMI female	Video Output: (1) HDMI female
	Serial Control Port: (1) DB9 female	Serial Control Port: (1) DB9 male
	Link Port: (1) RJ-45 female	Link Port: (1) RJ-45 female
	USB: (1) USB Type B female	USB: (4) USB Type A female
	Audio: (1) Line in, (1) Line out;	Audio: (1) Mic In, (1) Speaker Out
	Local Video Output: (1) HDMI female	N/A
DISTANCE	cable: Up to (100 m)	cable: Up to (100 m)
INDICATORS	(1) Power LED (red), (1) Link LED (green)	(1) Power LED (red), (1) Link LED (green)
MAXIMUM RESOLUTION	4K @ 30 Hz, 3840 x 2160 @ 30 Hz	4K @ 30 Hz, 3840 x 2160 @ 30 Hz
DDC SUPPORTED	DDC, DDC2, DDC2B	DDC, DDC2, DDC2B
HOUSING MATERIAL	Metal chassis	Metal chassis
OPERATING SYSTEM	OS independent	OS independent
ENVIRONMENTAL	Operating Temperature: 32 to 122° F (0 to 50° C);	Operating Temperature: 32 to 122° F (0 to 50° C);
	Storage Temperature: -4 to +140° F (-20 to +60° C);	Storage Temperature: -4 to +140° F (-20 to +60° C);
	Operating Humidity: 0 to 80%, noncondensing	Operating Humidity: 0 to 80%, noncondensing
POWER	External 5-VDC, 2-A power supply	External 5-VDC, 2-A power supply
DIMENSIONS	0.83" H x 3.27" W x 7.09" D (2.1 x 8.3 x 18 cm)	0.83" H x 3.27" W x 7.09" D (2.1 x 8.3 x 18 cm)
WEIGHT	0.82 lb. (0.372 kg)	0.83 lb. (0.378 kg)



KVM (Keyboard Video Mouse) Switch Specifications:

Computer Connections	Direct		8
Port Sections	Max		64 (via cascade) OSD, Hotkeys, Pushbuttons
Connectors	Console Port	Keyboard Video Mouse	1 x SPHD-18 Male (Yellow)
	KVM Ports	Keyboard Video Mouse	8 x SPHD – 15 Female (Yellow)
Switches	FW Upgrade Power Port F/W Upgrade		1 x RJ-11 Female (Black) 1 x DC Jack 8 x Pushbuttons 1 x Slide
LEDs Emulation	On Line Selected Power Keyboard/Mouse		8 (Orange) 8 (Green) 1 (Dark Green) USB
Video Scan Intervals Power Consumption			2048 x 1536, DDC2B 1-255 Seconds DC 5.3 V, 5 W
Environment	Operating Temperature Storage Temperature Humidity		0 – 50 C 20 – 60 C 0 – 80% RH Non-condensing
Physical properties	Housing Weight Dimensions (L x W x H)		Metal 1.89 kg 43.72 x 16.13 x 4.40cm



26.7.8 SOFTWARE LICENSES

a) The software shall be provided with all necessary software licenses to allow operation of the system as specified and as supplied. Licenses shall cover all software; including, but not limited to, operating systems and networking software. Licenses shall be for an unlimited time for use on the hardware provided as part of the Contract or their successors. Licenses shall allow upgrade to new versions of the software in the future. Licenses shall not be location specific within the SCADA system, but shall cover the use of the system by the OWNER and ENGINEER for software development during construction.

b) All software licenses shall be provided to the SPCS Section

26.7.9 INTELLECTUAL PROPERTY

a) The whole developed product will be the property of the CCT

[redacted]

26.8 **INPUT / OUTPUT LIST**

PART 1 – GENERAL

[redacted]

Facility	Description	Type	Low	High	Units	PLC#	Bldg #	Tag Suffix	Tag Name	IO Name	Chassis Slot	Point Type	Comments
BLKHT	BLACKHEATH WATER TREATMENT PLANT	DI	0	1		1	INLET	DI	BLKHT_PLC1INLET DI				

26.9 CONTROL DESCRIPTIONS

PART 1 - GENERAL

26.9.1 DESCRIPTION

Scope:

CONTRACTOR shall provide all labour, materials, equipment and incidentals as shown on the Drawings, specified and required to configure the SCADA System to accomplish the functionality specified herein.

26.9.2 PART 2 - EXECUTION

SCADA and PLC generated alarms and indications:

Alarm / Indication	Priority	Comment

Set points/data to be entered by the operator at the SCADA System:

Set point	Range / Typical Value

Historical Database and Trends:

Description	Trend Tag	Loop Number/s

[redacted]

Colour Coding

Symbol		Condition	Colour	Blink
1	Control Mode	SCADA Auto	Yellow	
		SCADA Manual	White	
		MCC Control	White	
2	Power Status	No Power on Bus Bar	Red	
		Power on Bus Bar	White	
3	Simulation Mode	Motor in mode simulation	White/Yellow	
4	Running Status	Stopped	White	
		Fwd Starting	Green/White	X
		Rev Starting	Green	
		Fwd Running	Green	
		Rev Running	Green	
5	Device Status	Unavailable	Grey	
		Available	White	
		Fault	Red/White	X
6	Equipment faults	Max Starts Per Hour	Red	
		Tripped	Red	
		Discrepancy	Red	
		Emergency Stop	Red	
		Thermistor	Red	
		Common Fault	Red	
		Main Fault	Red	
7	Interlock Status	Process Interlock	Purple	
8	Starts/Hr SP	NBSPH (Integer)	Grey	
9	Discrepancy	Discrepancy period	Grey	
10	Command Genset	GEN = 1 DUTY YES	Green	
		GEN = 0 DUTY NO	Green	
11	Power stage setting	Power stage setting	Grey	

[redacted]

26.10 OPTICAL FIBRE SPECIFICATIONS

INTRODUCTION

Fibre optic communication is a method of conveying data by sending light beams (photons) through optical fibre. Because of its advantages over electrical transmission, optical fibres have essentially become the Telecommunication industry and global standard replacing copper wire communications in Network infrastructure.

The Specialised Technical Services Department utilises mainly fibre optic cables and technology to connect PLC (Programmable Logic Controllers) networks- from the parts of the Treatment Plants to Process Control Centres and - within 2 km Network infrastructure.

26.11 TECHNICAL SPECIFICATIONS

26.11.1 Types of Optical Fibre cables

Multi-mode and Single Mode fibre cables shall be used (Project Specific and taking into account the distances)

Multi-mode fibre cable shall be used mainly used to transmit across comparatively shorter distances (less than 400 m) and Single Mode fibre cable for long distances

26.11.2 Multimode Fibres Cables

The following types of Multimode Fibre Cable and Specifications shall be used and their specifications as outlined by the ISO/IEC 11801 standard. (Project specific)

26.11.3 OM1

Jacket Colour – Orange

Core Size - 62.5um

Data Rate – 1 GB @ 850nm wavelength

Distance – Up to 300 meters

26.11.4 OM2

Jacket Colour – Orange

Core Size - 50um

Data Rate – 1 GB @ 850nm wavelength

Distance – Up to 600 meters

26.11.5 OM3 – Laser-Optimized Multimode

Jacket Colour – Aqua

Core Size - 50um

Data Rate – 10 GB @ 850nm wavelength

Distance – Up to 300 meters

Uses fewer modes of light, enabling increased speeds

Able to run 40GB or 100GB up to 100 meters utilizing an MPO connector

26.11.6 OM4 – Laser Optimized Multimode

Jacket Colour – Aqua

Core Size - 50um

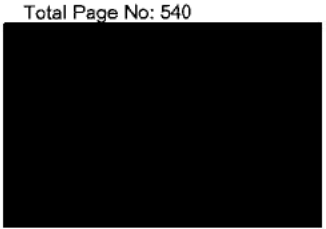
Data Rate – 10G @ 850nm wavelength

Distance – Up to 550 meters

Able to run 100GB up to 150 meters utilizing an MPO connector

26.11.7 OM5 – The latest and greatest in Multimode Fibre

Jacket Colour – Lime Green



Fully compatible and can mate with OM3 and OM4 cabling.

Utilizes a wider range of wavelengths between 850nm and 953nm

Designed to support Short Wavelength Division Multiplexing (SWDM)

Can Transmit 40 GB/s and 100 GB/s

26.11.8 Single Mode Fibre cables – OS1 and OS2

The following types of Single mode Fibre R Cable and Specifications shall be used and their specifications as outlined by the ISO/IEC 11801 standard. (Project specific).

26.11.9 OS1 Single Mode Tight Buffered Cable (Indoor Use)

This type of a cable shall be used for the moderate distances and OS1 can support speeds up to 10G and distances up to about 10km.

26.11.10 OS2 Single Mode Loose Tube Cable (Outdoor Use)

This type of a cable shall be used for the long distances and OS2 can support speeds up to 100G and distances up to 200km.

26.11.11 Optical Connectors

The City of Cape Town Specialised Technical Services shall employ No Polish connectors (NPC) to help enable fast, on-site installation of 250µm and 900µm single mode and multimode fibre.

There is a variety of fibre connectors used on Networks and SC and LC connectors are the most common types on the market. However, the City of Cape Town Specialized Technical Services Department shall employs the LC connectors.

LC connectors are smaller than the older style SC connectors, allowing more fibre ports per unit of rack space.

26.11.12 Patch Panels

The patch panel provides mounting locations for terminations and splices, and provides a secure connection space for connecting customer patch leads to the network.

b) All connectors will be LC-APC
c) The panel shall provide mounting locations for fibre termination and splices
d) The panel shall provide a secure connection space for connecting Client patch leads to the Network
e) Patch Panels are to be installed in building basements or lower ground floors unless otherwise instructed by the OWNER

Wall mount option or rack mount option. The preference is for a rack mount option and the 'swing-out' panel shall be used.

Wall-mount panels, currently there are two approved versions: The Tank Venus 4F/8F and the Tank (double door) 12F/24F/48F.

26.12 ENVIRONMENTAL CONSIDERATIONS

It is the Contractor and/or Client's responsibility to prepare a site-specific Environmental Management Plan (EMP). And, as ever, each site is unique and therefore the environmental issues to be considered will vary from site to site.

26.12.1 Environmental Control Officer (ECO)

a) A good place to start with, is the appointment of an Environmental Control Officer (ECO).
b) In order for all to sleep easily at night, without having to furrow the brow much with care, the ECO shall:
c) Prior to work commencing, the contractor shall unravel the requirements of the EMP to team members, to ensure understanding and conformity
d) Visit the site weekly
e) Review and approve all areas that have been rehabilitated by the Contractor
f) Keep a record of findings
g) Attend all project meetings
h) Produce a monthly report, for the client, with commentary on compliance and/or noncompliance

[redacted]

i) Keep an Incident Log of non-compliance
j) Maintain a record of complaints from the public and communicate this to the client
k) Where necessary, issue a non-compliance report to the Contractor
l) Where serious environmental infringements have occurred, introduce a Temporary Work Stoppage
m) Liaise with the appointed Occupational Health and Safety Officer of the client

26.12.2 **The Contractor's Environmental Management Plan (EMP) must include:**

The following, is a brief summary of what an EMP might contain, but is not limited to:

a) Statement of Commitment
b) List of activity-specific environmental issues related to your site and their likely impact
c) Incorporating the above, write a series of simple work instructions to ensure compliance
d) Determine the actions required to manage each work instruction
e) A list of tangible contingency and mitigating actions to be implemented if required
f) Provide training to staff and create awareness
g) An organizational chart setting out respective roles and responsibilities _
h) Monitoring and Reporting

26.12.3 **Contractor Responsibilities (not limited to):**

a) Be familiar with and comply with the procedures contained in the EMP.
b) Ensure that all personnel are trained, qualified and experienced enough, to undertake their work in an environmentally responsible manner.
c) Create an awareness of the Environmental work requirements and the need for them amongst the workforce.
d) Procedural briefings to be given before personnel carry out key activities for the first time.
e) Ensure that personnel who have formal responsibilities under this plan, are trained in the requirements of this EMP.
f) Undertake daily site inspections to monitor environmental performance and compliance.
g) Immediately notify the ECO in the event of infringements.
h) Notify the ECO and in advance of any activity he has reason to believe that may potentially have an adverse environmental impact.
i) It is desirable for Environmental matters to be included as a standard agenda item at all project meetings.

26.12.4 **Activity-specific Guideline:**

The following are the activity an EMP must contain, but is not limited to:

26.12.5 **Water**

a) Storm water shall be contained in the storm water system to avert flooding.
b) Measures shall be implemented to distribute storm water as evenly as possible to fend-off soil erosion.
c) Material from any stockpile shall not be allowed to spill or be washed into a gutter or drain.
d) The execution of any work shall not block and subsequently unsettle the existing overland water flow or the existing system of drains.
e) No person may, without prior written permission release water onto a public road.
f) Any water that is present in a trench shall be pumped out before backfilling.
g) Water shall be pumped into the storm water system and never into a sewer manhole.
h) No work shall be carried out within 32m of any natural water source without permission from the ECO.

26.12.6 **Dust / Air Pollution**

a) Where necessary, issue workers with washable dust masks for protection against dust inhalation.
b) Dust shall be controlled onsite, especially when windy.
c) Minimize or even cease activity during periods of high wind.
d) Dampen surfaces to prevent dust from becoming airborne.
e) Cover materials being transported with plastic sheeting or a tarpaulin to prevent them from flying off the vehicle. Dampening of the transported material may also be necessary.
f) Cover onsite stockpiles with plastic sheeting or tarpaulins during high wind.
g) Regular maintenance of generators, compressors, etc., is essential for controlling exhaust emissions.
h) Noise Pollution

[redacted]

i) Contractors shall abide by the National Noise laws.
j) Develop a noise mitigation plan before starting with construction.
k) The level of noise and the duration thereof must be agreed upon and monitored.
l) Examples of noise: Jack hammers, concrete saws, bulldozers, trucks, generators, compressors, pneumatic tools, power tools, etc.
m) Hand-held sound meters are lightweight, easy to operate and relatively inexpensive.
n) Hearing protection shall be worn at all times when noise levels are suspected of equaling or exceeding 85 dBA.
o) Noise PPE:
p) Use disposable earplugs only once
q) Keep reusable earplugs clean

26.12.7 Trees

a) Trees shall not be cut or trimmed unless consent is obtained in writing from the OWNER or the relevant authority.
b) Cutting shall be confined to what is absolutely necessary.
c) Tree roots exposed in the way of the trenching shall not be cut unless absolutely unavoidable.

26.12.8 Concrete / Cement

d) Concrete shall not be mixed directly on the ground.
e) All visible remains of excess concrete shall be removed and disposed at an approved disposal site.
f) Cement shall be stored in a dry place, protected from rain and raised off the floor.

26.12.9 Wayleave's

Wayleave's shall indicate the positions of all other services and the accuracy of the information shall be presented in a Wayleave.

A Wayleave agreement shall be obtained prior to installing any equipment.

The CONTRACTOR shall at all times keep a copy of the Wayleave on site.

The CONTRACTOR shall familiarise themselves with the Standards and special conditions as set out in this permit.

The CONTRACTOR shall be held responsible and accountable for the quality of work they deliver, as well as any objectionable actions by their workforce.

26.12.10 Trenching

The trenches shall be excavated to a depth that the crown of the duct has at least 800mm of backfill cover, in all soil conditions, except for where hard rock conditions are encountered.

Where it is not possible to obtain the specified minimum trench depth, the client must be consulted.

The trench depth in hard rock conditions shall be relaxed (i.e. apply for a concession) to a minimum depth of 300mm backfill cover over the uppermost duct. This shall require the protection in the form of a concrete slab (either pre-cast, or cast in situ) placed on top of the padding material before backfilling. This concrete slab shall have a strength of 20 MPA reinforced with high tensile wires and measure; 75mm thick by 300mm wide, and 900mm in length.

26.12.11 Trenches Deeper than 1.2 meters

a) Where the depth of a trench exceeds 1.2m and workers need to enter the trench, adequate measures must be taken by the contractor to provide support for this trench.
b) Three methods shall be used for protecting workers against trench cave-ins are:
c) sloping
d) trench boxes
e) shoring and, a ladder provides a safe means of access
f) Barricades and signs are to be used at safe distances from edges to protect unattended excavations.
g) No person must work alone in an excavation or trench that is greater than 1.2m deep.
h) Machinery must never be placed in or near excavations and trenches where exhaust fumes may contaminate below ground atmospheres that workers are required to occupy._
i) Care shall be exercised in the moving or removal of shoring to prevent the caving or collapse of the trench faces being supported.

[redacted]

26.12.12 **Pilot Holes**

When the trench has been set out, Pilot Holes shall be dug at 30 - 50m intervals, at points where the new trench crosses existing services. The pilot holes shall be at least 150mm deeper and wider than the proposed trench.

Pilot holes shall be utilized not only for the location of the services, but also to determine the position of a trench, relative to other services.

26.12.13 **Road Crossings**

a) The contractor shall inform the Treatment Plant authority 48-hours prior to the commencement of the work.
b) Directional drilling shall be the preferred method for crossing roads.
c) The Contractor to ensure that every law regarding traffic, safety, traffic signs and barricading is complied with.
d) The angle of the crossing should be as near a right angle to the road centerline as possible.
e) The edge of the trench must be cut using asphalt/concrete cutters to deliver smooth, uniform edges.
f) The minimum depth that any service may be placed under a road is 800 mm.
g) The duct/s shall extend a distance of at least 0.5m beyond the edge of the road.
h) All excavated material and equipment must be placed and demarcated in such a way to not inconvenience vehicles and pedestrians.
i) Trenching Near Power Cables
j) Where no physical barrier exists, no duct or cable shall be laid within a distance of 600mm measured horizontally, nor cross within a distance of 300mm measured vertically from any high voltage power cable.
k) Where this separation is compromised, the duct or cable must be separated by concrete slabs.
l) The standard protection slab is 900mm x 300mm x 75mm thick. This slab will be reinforced with 3.55mm high tensile wires.

26.12.14 **Manholes and Hand-holes**

a) MHs and HHs shall be positioned as far away as possible from road junctions.
b) MHs and HHs must to be built according to prescribed dimensions and specifications.
c) Before any concrete is placed the Contractor shall examine the shuttering for firmness and correctness of position and remove all dirt and other foreign matter.
d) Hand mixing of concrete is permitted in exceptional cases but only with written permission of the client.
e) Concrete mix shall be such that a strength of 20MPa (2.5:2.5:1) is obtained 28 days after pouring._
f) Duct entry points into HHs / MHs must be drilled, without cracking or damaging the surrounding structure.
g) Ducts shall enter and exit HHs / MHs in line with the direction of the route, for them to be coupled thru without any obvious effort, as a continuous duct._
h) HH / MH external labelling should be done on the coping and NOT the lid, as lids can get damaged and be replaced. GPS coordinates must be recorded._
i) On completion of a HH / MH, the Contractor shall re-instate the area around the HH / MH to its original state or better.

[redacted]

26.12.15 **Quality inspection sheet**

Trenching and duct placement		OK	NOT OK	N / A
1	Wayleave agreements			
2	Traffic Management			
3	Personal protective equipment			
4	Barricading			
5	Environmental Considerations			
6	Businesses / Property owner notifications			
7	Location if services			
8	Pilot Services			
9	Power cable separation			
10	Trench depth			
11	Trench width			
12	Bedding and padding			
13	Vertical or Horizontal duct de-coiler used			
14	No Duct directional changes			
15	End caps on ducts			
16	Warning / marketing rape placed			
17	Backfill OMC			
18	DCP Test			
19	Site tidy and clean			
20	Reinstatement			

Manholes and Hand holes		OK	NOT OK	N / A
1	MH / HH cover seal			
2	Approved foot-roadway frame and cover			
3	MH /HH walls watertight			
4	Ducts secured			
5	End caps fitted on empty ducts			
6	Use ducts sealed between cable and duct			
7	Cable slack neatly stored			
8	Cables and ducts labelled			
9	MH/ HH marked on the coping			
10	Splice closures secured			
11	HH/MH tidy, clean and dry			

[redacted]

27 TELEMETRY SYSTEM

27.1 RETICULATION PUMP STATIONS TELEMETRY SYSTEM

(See page 70 for Bulk Water Guideline Specification)

Remote Terminal Unit (RTU) Specification

Introduction

27.1.1 TITLE

Specification for telemetry equipment and installation at water and wastewater pump stations and reservoirs.

27.1.2 Purpose

To provide standards for equipment, functionality and installation of telemetry Remote Terminal Units (RTU's) to be install at water and wastewater pump stations and reservoirs.

27.1.3 BACKGROUND

This specification describes the Remote Terminal Unit (RTU) to be installed on the Reticulation Telemetry for pump stations and reservoirs using Terrestrial Trunked Radio (Tetra) modem as a primary communication medium. Telemetry is a means of remote monitoring and control of reservoir levels, pump stops/starts, overflows and other important information from water & sewage outstations.

DATA gathered by the RTU is transported to a Central SCADA system running on the Adroit software suit. The RTU will be programmed to operate in the following manner:

a) **I/O.** The RTU must cater for a minimum of 32 digital inputs and 5 differential 4 to 20 mA analogue inputs and 4 voltage free relay outputs. Each analogue input to be Isolated.
b) **Event driven.** The RTU will be programmed to send alarm data on an event bases to the SCADA thus when an alarm is raised the RTU initiates the transmission.
c) **Logging.** Values will be logged at a 1 minute interval and periodically downloaded through the SCADA with data catch-up facilities should communications be interrupted.
d) **Power management.** The RTU will run a power management programme. This will have two time periods per day whereby the RTU will endeavor to hold off pumping to conserve electrical power during peak demand periods. The time and duration will be set for each pump station from the SCADA.
e) **Communications.** The RTU must communicate to the central SCADA via a TETRA packet data modem (OBCU).

27.1.4 CENTRAL PROCESSOR UNIT (CPU)

The CPU will be a Spectrum Tele Flex (5) system. Spectrum Communications (Pty) Ltd was awarded a tender (71S/2009/10) to upgrade the entire RETICULATION TELEMETRY network.

Through this tender over 510 reticulation outstations having been configured to send data to the

New Central SCADA system. All new installations shall comply with this specification using a Teleflex 05 CPU and a Tetra Modem. The Tele Flex RTU will run a power management programme. This will have two time periods per day whereby the RTU will endeavour to hold off pumping to conserve electrical power during peak demand periods. The time and duration will be set for each pump station from the SCADA.

If a PLC to Telemetry RTU is required, the on-board Teleflex **Ethernet port** shall be used.

27.1.4.1 Display Unit (HMI)

a) The display unit must indicate the status of each pump (Running/Tripped).
b) The display unit must indicate each pump motor current (red phase only).
c) The display unit must indicate each pump's running hours and number of starts since reset.
d) The display unit must indicate all levels and flows.
e) The display unit must indicate all alarm states

The minimum size for HMI's is 15" unless the CCT rep suggest a smaller display for minor processes with very little data to display.

[redacted]

27.1.4.2 **Configuration**

Transmission must be on an exception basis to the central with a periodic poll from the central. The central must poll at least every 4 hours to check communications to each outstation.

All digital inputs must have a configurable hold off time "de-bounced" for a period of **35 seconds** except the alarm trigger inputs.

All analogue inputs must have a configurable hold off time for a period of 60 seconds. All analogue inputs must have a dead band of 5% of full scale (20mA) unless otherwise stated. The RTU will log all analogues and register values with a date and time stamp every 5 minutes. The log values will be updated at the central station when RTU sends data to it.

27.1.4.3 **RTU Program**

Standard Operating Program

A switch on the Electrical Motor Control Panel will drive one of the RTU's digital inputs, (see I/O schedule, annexure A), to switch the RTU into Manual Mode, Ultrasonic Mode or Remote Mode (RTU control).

f)Water Outstations- [Manual and Automatic Mode]

g) Waste Outstations- [Manual Mode, Ultrasonic Mode or Remote Mode]

When in Manual Mode the RTU will monitor and report all status and parameters but not control any pumps. When in Remote mode the RTU will control the starting and stopping of pumps based on levels received from their analogue input or from another RTU.

Each duty pump will have a START set point and a STOP set point, see I/O schedule for number of pumps. All set points must be able to be modified, under password control, through the local display (HMI) and remotely from the SCADA.

The RTU must perform duty selection, where the next available pump to start has the lowest running hours or set, under password control, through the local display (HMI) and remotely from the SCADA. The RTU will sum each pump's Running Hours up to 99 999 hours with a 0.01 hour, resolution whereupon the counter will roll over.

The Running Hours must be able to be reset, under password control, through the local display (HMI) and remotely from the SCADA.

The Number of Starts must be able to be reset, under password control, through the local display (HMI) and remotely from the SCADA.

A number of sites will require pumps at one location to be operated based on measurable items at a second location (separate RTU's), communicating via the Central Station (Adroit Server).

27.1.4.4 **Electrical Demand Side Management Program**

The RTU must be programmed to perform Electrical Demand Side Management, which can be remotely activated or deactivated from the SCADA. The RTU must have two periods per day to implement electrical side management as follows: When the RTU's real time clock reaches the start time of each period the RTU must set its outputs to pump the level down to a LOW set point (or HIGH for a reservoir).

Once the set point has been reached the RTU must set its outputs to stop the pumps. The RTU must hold its outputs off to prevent the pumps from running until immediately after its real time clock has passed the end time for that period or until the HIGH set point is reached. After the end period had passed normal level control must resume.

Should the high set point be reached before the end of the period the RTU's outputs must be set to pump the level down to the LOW set point.

The start and end times for each period must be stored in the RTU. The start time and end times for each period must be able to be set remotely from the SCADA at the central station. The LOW set point must be able to be set remotely from the SCADA at the central. The HIGH set point must be able to be set remotely from the SCADA at the central.

27.1.4.5 **Intrusion Alarm System**

The RTU must be programmed to perform the function of intruder alarm detection. The intrusion alarm will operate when the RTU is in either Local or Remote Mode. The alarm must be activated or

[redacted]

deactivated by entering a code on the local display (HMI) or remotely from the SCADA under password control.

The RTU must have the capability of storing 10 alarm codes used for activating/deactivating the alarm. The alarm codes must be able to be programmed into the RTU (locally), under password control, through the local display (HMI) and also remotely from the SCADA. When the alarm is activated or deactivated the status must be reported to the central station along with the code entered.

When setting the alarm there must be a 30 second delay after entering the code before the alarm is activated, during which a buzzer will beep periodically. After the alarm is triggered there must be a 30 second delay, during which a buzzer will beep periodically, to allow the code to be entered before raising an alarm. The alarm must be triggered from one of the RTU's digital inputs detecting an open circuit. See I/O listing. Once the alarm has been raised the RTU must report the status to the Central Station and drive one of its digital outputs closed for a period of 3 minutes, see I/O listing. Only after the alarm has been deactivated will it be able to raise a new alarm. Contractor shall supply and install magnetic locks, Passive Infrared Sensors (PIR).

27.1.5 COMMUNICATION

The Spectrum RTU shall communicate with the central station via dual TETRA /GPRS modem called On Board Computer Unit (OBCU). These modems communicate with a RAMM switch, which was developed for the City of Cape Town. The data packets sent by the RTU will be delivered to the RAMM switch and central station is configured to access data on the RAMM switch for Monitoring and Display on Adroit SCADA.

The OBCU is interfaced to the CPU and forwards data packets to master SCADA station using dual networks consisting of City of Cape Town's Tetra Radio packet data network (Primary) and a GSM network (Secondary). It is the duty of tenderer to ensure communication with modem, switch and central station. RTU must be able to be fully configured from the central station. The central station is situated in Bellville at City of Cape Town Radio Control Centre – SPEARS

27.1.6 RTU MOUNTING POSITION AND DISPLAY

The RTU must be firmly secured using bolts or other suitable fixings and the Engineer shall approve final position on site. Final position of the Display Unit to be approve by the Engineer (normally closer to the access door to enable ARM /DISARM of Outstation

27.1.6.1 Enclosure

Material: 3CR12 or Aluzinc stainless steel powder coated unless otherwise stated, same colour as the Electrical DB.

All cable entry via IP 65 compression glands mounted on the bottom of the enclosure.

All equipment and terminals must be mounted on a backplane.

All terminals must be rail mount.

27.1.6.2 Power Supply

The RTU power supply unit (PSU) shall be of the "switch mode" type with 12 Volt output, capable of supplying 2 amperes continuous current.

The input voltage is nominally 230V AC, at 50Hz.

The RTU power supply unit (PSU) must maintain the standby battery at 13.8V while supplying a separate isolated supply to the RTU with load shedding

27.1.6.3 Wiring

Interface Instrumentation cable shall be constructed of multiple twisted pairs of insulated stranded copper wire, PVC insulated with an overall aluminium shield, extruded PVC inner jacket, served with steel wire armour with an extruded PVC outer jacket.

The nominal conductor resistance shall not exceed 3, 5 ohms per 100 m at 20°C.

The complete cable shall withstand a dielectric test conductor to conductor and conductor to shield of 1 000 V dc for one minute.

The insulation resistance of each conductor shall be not less than 8 800 Meg ohms/km for 1 minute at 500 V and 20°C, measured with the remaining conductors in the cable connected to the armouring.



The minimum core size shall be 0.75 mm².

All instrumentation and signal cables (excluding optical fibre cables) shall be installed separate from power cables.

The control wiring shall be terminated in corrosion - proof terminals.

All internal wiring shall be number ferruled in accordance with the wiring diagrams supplied by the Contractor.

All control wiring shall be marked in accordance with the Contractor's wiring diagram with black lettering on white PVC ferrule type cable markers placed on the cable adjacent to each connection.

All inter-RTU wiring shall be accommodated in trunking. Separate terminals shall be provided at the base of the RTU to accommodate the incoming and outgoing control circuits and power circuit

27.1.7 CONTRACTOR MANAGEMENT

a) All equipment must be approved by the engineer prior to installation.
a) The control philosophies and any programing algorithms must be approved by the engineer prior to RTU or system programming.
b) The tenderer must allow for a minimum of 4 iterations of the SCADA mimics
c) All SCADA mimics must be approved by the engineer before deployment
d) A simulated test from the RTU to the SCADA using the live communications must be performed to the satisfaction of the engineer prior to commissioning.
e) RTU Alarm codes must be able to be programmed by user into the CPU remotely from TOC and locally.
f) All RTU parameters must be able to be updated, by user, from the central station (TOC)
g) All equipment must be approved by the engineer prior to installation.

27.1.8 RTU STANDBY BATTERY

12 Volt DC 17/18 Ah

Rechargeable, Maintenance free,

Valve Regulated Sealed lead acid battery.

Dimensions: L= 180 mm; W=80 mm and H = 160 mm

(Standby Battery to power RTU in event of a power failure (220V supply)

27.1.9 SCADA CONFIGURATION

SCADA MIMICS, NAVIGATION, EVENTS, ALARMS and TRENDS to match the current configuration at the Central System at Technical Operating Centre (TOC) and should a plant have additional information from the norm, all should be displayed in the mimic.

MIMICS must depict a common segment of the process.

27.1.10 VIZNET IMPLEMENTATION

A Viznet Implementation of the SCADA mimics must be developed and reside on the data base server following and existing format or if a new format is required, approval to be obtained from City of Cape Town Telemetry Manager.

27.1.11 GENERAL

Contractor shall supply and install FLOATS Switches and Level Transducers as per I/O list.

Contractor shall supply and install Current Transformers to measure Pump Currents as per I/O list and any other required site specific Telemetry Interfacing equipment.

Additional I/O modules shall be added upon an outstation specific need (if more than 32 Digital Inputs are required)

27.1.12 I/O MODULES

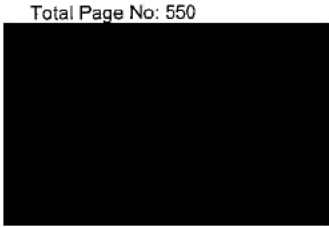
Water Outstation (I/0):

No	Digital Inputs



1	Overflow
2	Reservoir High Level (Destination)
3	Reservoir Low Level (Destination)
4	Sump - High Level(Source Res)
5	Phase fail
6	Pump 1 -Duty
7	Pump 1 -Auto
8	Pump 1 -Trip
9	Pump 1 -Manual
10	Pump 1 -Run from Contactor
11	Pump 2 -Duty
12	Pump 2 -Auto
13	Pump 2 -Trip
14	Pump 2 -Manual
15	Pump 2 -Run from Contactor
16	Pump 3 -Duty
17	Pump 3 -Auto
18	Pump 3 -Trip
19	Pump 3 -Manual
20	Pump 3 - Run from Contactor
21	Alarm Input-1
22	Alarm Input-2
23	Alarm Input-3
24	Telemetry mains fail- [RTU: 220V]
25	Telemetry intruder alarm
26	Res- Ultrasonic alarm - 1
27	Sump- Ultrasonic alarm - 2
28	Station Manual (local) control (SMC)
29	Sump- Low Level(Source Res)
30	Station Telemetry control (STC)
31	Remote ARM/Disarm Alarm

No	Analogue Inputs
1	Sump 1 level (Res)
2	Sump 2 level (Sump)
3	Motor Current- 1
4	Motor Current- 2
5	Motor Current- 3
	Outputs
1	Siren
2	Pump 1- Run
3	Pump 2- Run



No	Analogue Inputs
4	Pump 3- Run

Sewage Outstation (I/0)

No	Digital Inputs
1	Overflow
2	Wet well high- 1
3	Wet well high -2
4	Dry well high -1
5	Phase fail
6	Pump 1 -Duty
7	Pump 1 -Auto
8	Pump 1 -Trip
9	Pump 1 -Manual
10	Pump 1 -Run from Contactor
11	Pump 2 -Duty
12	Pump 2 -Auto
13	Pump 2 -Trip
14	Pump 2 -Manual
15	Pump 2 -Run from Contactor
16	Pump 3 -Duty
17	Pump 3 -Auto
18	Pump 3 -Trip
19	Pump 3 -Manual
20	Pump 3 - Run from Contactor
21	Alarm Input-1
22	Alarm Input-2
23	Alarm Input-3
24	Telemetry mains fail- [RTU: 220V]
25	Telemetry intruder
26	Ultrasonic alarm 1
27	Ultrasonic alarm 2
28	Station Manual (local) control (SMC)
29	Station Ultrasonic control (SUC)
30	Station Telemetry control (STC)
31	Remote ARM/Disarm Alarm

No	Analogue Inputs
1	Sump 1 level
2	Sump 2 level
3	Motor Current 1
4	Motor Current 2
5	Motor Current 3



No	Outputs
1	Siren
2	Pump 1 Run
3	Pump 2 Run
4	Pump 3 Run

The Digital inputs shall be of the dry relay contact type. The Analogue inputs shall be isolated and of the differential 4 to 20 mA type. Additional I/O modules shall be added upon an outstation specific need (if more than 32 Digital Inputs are required).

[redacted]

27.2 BULK WATER TELEMETRY SYSTEM

27.2.1 Overview

The City of Cape Town (CCT) maintains a telemetry system for operational control and management information of its Bulk Water infrastructure, covering the greater Cape Town metropole. The telemetry system is based on the Motorola MOSCAD Remote Terminal Unit (RTU). It was first installed in 1999 and has grown to over 80 RTUs. It communicates using Motorola's proprietary Motorola Data Link Communications (MDLC) protocol. The systems utilises UHF analogue Radios as the communication network necessitating the use of a central high site radio repeater as well as a few subsidiary repeaters. The equipment is over 15 years old and replacement units and parts are no longer manufactured. Additions to, and replacement of some of the existing equipment has utilised the Motorola ACE Remote Terminal Units (RTUs). These use the same MDLC protocol making the additions and replacements seamless.

The most efficient cost and operational upgrade path is to replace the existing MOSCAD 300/400/Lite units with the Motorola ACE units.

This will enable reuse of CCT existing software and allows a complex rollout plan to be seamless in that the old and new units can intercommunicate on the same network during the changeover period.

The UHF analog radios are to be replaced by TETRA radios which will use the CCT Emergency Radio system with its multiple high sites and cellular technology.

The TETRA system provides voice communication using handheld radios for emergency personnel and we have been authorized to use the TETRA data channel for telemetry data communication.

There is a requirement to keep the telemetry data to a minimum as the voice channels have priority.

27.2.2 Essential system requirements

Motorola MDLC protocol proprietary must be used for communication over TETRA radio.

TETRA version must be compatible with CCT latest version TETRA system.

Installers must be accredited and trained on specified equipment.

RTUs must have upgradable firmware.

RTUs must be error checkable online - i.e. from any RTU to another RTU over the TETRA network.

Error logs must be resettable over the TETRA network.

Application software must be programmable in "c" or "ladder logic".

Software application must be unloadable from any RTU to another RTU over the TETRA network.

Data communication over the TETRA network must be kept to a minimum (of the order of hundreds of bytes per day - not kilobytes).

Software filters must be used to prevent a faulty transducer producing excessive data communication.

Data changes shall only be communicated when a configurable dead band is exceeded.

27.2.3 Example of a Standard RTU:-

ACE3600 - Ethernet enabled

Module housing 3, 5 or 8 bay as required by number of input or output modules

TETRA radio Motorola MTN800E - enabled for CCT TETRA system

Panel mount antenna or fixed UHF aerial in the band 400MHz to 440 MHz

Antenna feeder cable must be RG 214 or of high specification

Active data cable (pmkn4104a) for connecting RTU to radio

1 x Mixed I/O module (16DI + 4 DO + 4AI MODULE)

1 x 8 analog input 4to20ma module

Battery - sealed 10 Ah

Wiring backplane with krone connectors

Option to take analog radio as well as TETRA must be included



Wall mount enclosure 750mm (high) x 550mm (wide) x 270mm (deep)

Equipment to be mounted on a backplane that fits into the above enclosure

Refer to attached equipment documentation for details.

The above equipment and other modules are available on a 3 year tender at present.

Tender 242G/2014/15 valid until 30 June 2018

Tender 243G/2014/15 valid until 30 June 2017

27.2.4 Existing Radio Network

When a new RTU is added to the network it must adhere to existing rules.

All RTUs use the same main part the CPU module and either TETRA or UHF analog Radio.

If the use requires input or output then the required modules are added.

There are 3 main type of system component that the above fall into:-

a) The Main Central (at present only one at 38 Wale Street)
b) The Sub-Centrals (six at present)
c) The Normal RTUs (70 at present)

Each type uses its own generic version of application software.

Having only 3 software versions is efficient and reduces code maintenance.

The tailoring to site specifics is done by an added configuration module.

The configuration sets the site number, link type, network info, in and output module info and where it reports to.

27.2.5 Adding RTUs to the System

a) Make sure that there is good TETRA signal coverage in the area.
b) If the inputs to be collected are within a relatively large area (1 to 2 km's) then consider using a PLC network to collect and report to a local SCADA by LAN especially when there are many inputs.
c) Larger geographical areas (>2km) then data can be brought back to the SCADA by a Normal RTU.
d) Generally operator controllers will acknowledge alarms and make decisions locally and only management information will be passed back to Main Central.

27.2.6 Detailed Specification:

27.2.6.1 CPU 3600 series

Microprocessor Freescale – Power PC II, MPC8720, 32-bit, extended communication capability, DMA and floating point calculation support

Microprocessor Clock 200 MHz

Memory Flash: 16 MB

DRAM: 32 MB

SRAM plug-in board (optional): 4 MB

a) Real-Time Clock Full calendar with leap year support (Year, Month, Day, Hours, Minutes, and Seconds) Time drift: max. 2.5 seconds per day (when power is on)
b) SRAM and RTC Retention 3 V Rechargeable lithium backup battery

Serial Port 1 Configurable RS-232C or RS-485 port:

a) RS-232C: A synch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface - RS-485, multi-drop 2-Wire up to 230.4 kb/s
b) Serial Port 2 RS-232C, Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface

Plug-In Port 1 supports the following Plug-In ports:

a) Radio Modem, DPSK 1.2 kb/s, FSK 1.2 / 1.8 / 2.4 kb/s, DFM 2.4/3.6/4.8 kb/s
b) RS-232, Sync/Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface
c) RS-485, multi-drop 2-wire, up to 230.4 kb/s
d) Ethernet 10/100 Mb/s

[redacted]

Plug-In Port 2 supports the following Plug-In ports:

a) Radio Modem, DPSK 1.2 kb/s, FSK 1.2 / 1.8 / 2.4 kb/s, DFM 2.4/3.6/4.8 kb/s and
b) RS-232, Sync/Asynch, Full Flow Control, up to 230.4 kb/s, GPS receiver interface
c) RS-485, multi-drop 2-Wire up to 230.4 kb/s
d) Ethernet 10 Mb/s

Ethernet Port 1 10/100 Mb/s, (on CPU 3640 only)

LEDs Display 4 CPU diagnostics LEDS, port status LEDs and user application LEDs

Power Consumption See ACE3600 Maximum Power Ratings below.

Operating Voltage 10. 8 -16 V DC (from the motherboard connector)

27.2.6.2 **AC Power Supply Module**

Input Voltage 100-240 V AC, 50/60 Hz

Total Power Max. 60 Watt continuous, Max. 105 Watt peak @ 25% duty cycle

Outputs Motherboard connector (to CPU and I/O modules): 13.2 V DC ±20%, max. 4 A AUX1A/AUX1B user connectors: 13.2V DC ±20%, max. 8 A, on/off controlled by user program

AUX2A/AUX2B: 13.2 V DC ±20%, max. 8A or 3.3, 5, 7.5, 9 V DC ±10% (configurable), max.

2.5A, on/off controlled by user program

Note: max. 8 A total current consumption from all outputs

Battery Charger 12 V Lead-Acid battery charger (in PS with charger)

Automatic charging of 6.5 or 10 Ah backup battery, battery temperature sensing, overcharging protection, battery capacity test and diagnostics, automatic battery switch-over

Diagnostics LEDs Status LED for: input voltage, AUX1 and AUX2 outputs, 12V control for DO modules and battery

No Load power consumption 130 mA @ 220 V AC

Efficiency 80% typical @230 V AC, 76% typical @115 V AC (full load)

Inrush Current 25 A maximum, for 2 ms. Max, cold start at 25°C

Power Factor 0.98 typical at 230 V AC, 0.99 typical at 115 V AC

Protection Internal Line Fuse, replaceable

Output Protection AUX2A/B Short Circuit, automatic recovery on 3.3, 5, 7.5, 9 V

Insulation Input to case: 1500 V AC, input to output: 3000 V AC

NOTE SELECTION OF I/O MODULES MAY BE SITE SPECIFIC

Typical module are indicated below

27.2.6.3 **Mixed I/O 16DI + 4DO + 4AI Modules**

Total Number of Inputs/Outputs 16 Digital Inputs + 4 EE Relay Outputs + 4 Analog Inputs, ±20 mA 16 Digital Inputs + 4 ML Relay Outputs + 4 Analog Inputs, ±20 mA I/O Arrangement 1 group of 16 DIs with shared common, 4 relay outputs - Form C, 4 isolated analog inputs

DI Counter Inputs The first 12 inputs can be configured as fast counters.

DI Frequency 0 - 1 KHz

DI Fast Counter Frequency 0 - 5 KHz minimum pulse width 100 µS DI Max. DC Voltage Max. 40 V DC

DI "ON" DC Voltage Range +11 to +30 V DC, -30 to -11 V DC

DI "OFF" DC Voltage Range -5 to +5 V DC

DI Current 6-10 mA

Fast Capture Resolution 1 ms (Interrupt upon change of state)

Event Time Tagging Resolution 1 ms (Interrupt upon change of state)

DI Filtering 0 to 50.8 ms (DC, programmable in 0.2 ms steps)

[redacted]

DI Counter Filtering 0 to 12.75 ms (programmable in 0.05 ms steps for inputs configured as high speed counters)

DO Contact Voltage Ratings Max. 60 V DC or 30 V AC RMS (42.4 V peak).

DO Contact Power Ratings 2A @ 30 V DC, 0.6A @ 60V DC or 0.6A @ 30V AC (resistive load) DO Relay Back Indication Contact position - hardware back indication

DO Fail State Configurable relay state on CPU fail: On, Off or 'last value'

AI Resolution 16 Bit (including sign)

AI Accuracy ±0.1% @ -40°C to +70°C

AI Sampling time 10 ms @ 50 Hz filtering, 8.33 ms @ 60 Hz filtering

AI Smoothing Selectable input averaging: 1, 2, 4, 8, 16, 32, 64 or 128 samples (x10 mS)

AI max. Potential between AIs 75 V DC, 60 V AC (RMS)

AI Impedance Rin < 250 Ω

AI Crosstalk Rejection Better than 80 dB between any pair of inputs

AI Temperature Stability Better than ±25 PPM/°C

AI Interference Suppression Selectable 50 or 60 Hz filtering, common mode rejection > 80 dB, differential mode rejection > 50 dB

Diagnostics LEDs LED per each input/output status, module error LED, 24V Plug-in status LED

24 V DC Output Supports one isolated 24V plug-in "Wetting" Power Supply

User Connection 4 Terminal Blocks (3.5mm pitch), Maximum 18 AWG

Cable & TB Holder 40 Wire Cable with Terminal Block Holder connector, 26 AWG

Module Replacement Hot swap replacement– module extraction/insertion under voltage

Input / Output Isolation DI: 2.5 kV RMS between input and module logic per IEC60255-5

DO: Between open contacts: 1kV, between output and module logic: 1.5 kV, per IEC60255-5

AI: 1.5 kV between input and module logic per IEC60255-5

Input Insulation resistance 100 MΩ @ 500 V DC per IEC60255-5

Operating Voltage 10.8-16 V DC and 3.3 V DC (from the motherboard connector)

Power Consumption See ACE3600 Maximum Power Ratings below.

EE Relay on: 0.2 W typical (15 mA @ 13.8 V DC at PS) (Not including 24 V Plug-in Power Supply)

27.2.6.4 **Mixed 4 Analog Output 8 Analog Input Modules**

Total Number of I/Os 4 AO + 8 AI (AI: ±20 mA or ±5 V DC)

I/O Arrangement AO - each channel can be connected as 0 -20 mA or 0-10 V, AI - Isolated (floating) analog inputs

AO D to A Resolution 14 Bit

AO Accuracy ±0.1% of full scale @25°C

AO Temperature Stability Better than ±25 PPM/°C

AO Internal Settling Time Max. 1 ms

AO Load Voltage: > 1.0 kΩ, < 1.0 µf, Current: < 750 Ω

AO Crosstalk Rejection Better than 50 dB between any pair of outputs

AO Interference Suppression Common Mode Rejection: > 60 dB

AO Voltage Output Protection Short-circuits protection, max. 30 mA

(All other operating channels remain fully functional)

AO Current output no-load voltage Max. 22 V DC

AO Isolation 1.5 kV between output and module logic

AO Insulation resistance 100 MΩ @ 500 V DC, per IEC60255-5



AI A to D Resolution 16 Bit (including sign)

AI Accuracy ±0.1% of full scale @ -40°C to +70°C

AI Sampling Time 10 ms @ 50 Hz filtering

8.33 ms @ 60 Hz filtering

AI Smoothing Selectable input averaging: 1, 2, 4, 8, 16, 32, 64 or 128 samples (x10 ms)

Permitted Potential between Inputs 75 V DC, 60 V AC (RMS)

AI Input Impedance ±20 mA input: Rin < 250 Ω

±5 V input: Rin > 1 MΩ

AI Crosstalk Rejection Better than 80 dB between any pair of inputs

AI Temperature Stability Better than ±25 PPM/°C

AI Interference Suppression Selectable 50 or 60 Hz filtering,

Common mode rejection > 80 dB,

Differential mode rejection > 50 dB

24 V DC Output Supports one optional isolated 24V Plug-in Power Supply

Diagnostics LEDs AO - Voltage mode LED, Current mode LED, Calibration LED per channel

AI - Overflow and Underflow LED per each input, 24V Plug-in status LED

The module Overflow and Underflow levels can be configured to: ±20mA/4-20 mA or ±5 V/0-5 V/1-5 V General - Module error LED

AI Input Isolation 1.5 kV between input and module logic

AI Input Insulation resistance 100 MΩ @ 500 V DC, per IEC60255-5

User Connection 4 Terminal Blocks (3.5mm pitch), Maximum 18 AWG

Cable & TB Holder 40 Wire Cable with Terminal Block Holder connector, 26 AWG

Module Replacement Hot swap replacement– module extraction/insertion under voltage

Operating Voltage 10.5-16 V DC and 3.3 V DC (from the motherboard connector)

27.2.6.5 **16/32 DI FAST 24 V MODULES**

Total Number of Inputs 16 DI

32 DI

Input Arrangement Isolated groups of 16 inputs with shared common

Fast Counter Inputs that can be used as fast counters:

a) All inputs in 16 DI module
b) First 20 inputs in 32 DI module

AC Input Frequency 45 – 65 Hz

AC Input Delay Maximum 0.2 ms

Fast Counter Input Frequency 0 - 12.5 KHz, minimum pulse width 40 µS

Max. DC Input Voltage Max. ±40 V DC (relative to input common)

"ON" DC Voltage Range +9 to +30 V DC, -30 to -9 V DC

"OFF" DC Voltage Range -3 to +3 V DC

"ON" AC Voltage Range 10 to 27 V AC (RMS)

"OFF" AC Voltage Range 0 to 5 V AC (RMS)

Input Current Max. 3.5 mA

Fast Capture Resolution 1ms (Interrupt upon change of state)

Event Time Tagging Resolution 1ms (Interrupt upon change of state)

Input Filtering 0 to 50.8ms (DC, programmable in 0.2ms steps)



Counter Input Filtering 0 to 12.75ms

(Programmable in 0.05ms steps for inputs configured as high speed counters)

24 V DC Output Supports optional isolated 24 V plug-in "Wetting" Power Supply (One in 16 DI, two in 32 DI)

Diagnostics LEDs Status LED per each input, module error LED, Plug-In 24V status LED

User Connection 2 or 4 Terminal Blocks (3.5mm pitch), Maximum 18 AWG

Cable & TB Holder 20 or 40 Wire cable with Terminal Block Holder connector, 26 AWG wires

Module Replacement Hot swap replacement – module extraction/insertion under voltage

Input Isolation 2.5 k V RMS between input and module logic per IEC60255-5

Input Insulation resistance 100 MΩ @ 500 V DC, per IEC60255-5

Operating Voltage 10.8 -16 V DC and 3.3 V DC (from the motherboard connector)



28 POWER FACTOR CORRECTION EQUIPMENT

28.1 GENERAL

The Power Factor Correction (PFC) control equipment shall be housed within a tier entitled "PFC" with the associated capacitors, mounted within the proposed Motor Control Centre Switchboard.

The required equipment arrangement on the front of the "PFC" tier is as depicted on drawing No.EAM-EE-GS-022 entitled "Typical Power Factor Correction Panel Layout".

The proposed power factor correction value required shall be as per the Project Specification.

The power factor for the installation shall be corrected to not less than 0.98 lagging for all load conditions. A 6-step Reactive Control Relay shall be employed for the controlled switching of the 6 required capacitors to achieve the target power factor value. If this is insufficient, a 12step controller may be employed, noting that each capacitor may not be larger than 50kVar.

28.2 VENTILATION

The "PFC" tier and the cubicle housing the capacitors shall be designed for and equipment arranged for adequate airflow. Ventilation shall be by natural convection within the respective cubicle, but both cubicles shall be fitted with ventilation fans installed in the rear door of each cubicle, to transfer heat to the ambient.

28.3 CAPACITORS

Capacitors for power factor correction shall be arranged for operation on the three phase system and shall meet the following requirements:-

28.3.1 General

Suitable for power installations where harmonics, generated by single or multiple Variable Frequency Drives are known to exist and where inductors are employed to assist in filtering these harmonics. Only 3-Phase capacitors are acceptable.

Filled with non-toxic, biodegradable, PCB free oil. Vacuum impregnated with biodegradable impregnating oil.

Provided with a container which shall not rupture or leak even after the capacitor is no longer serviceable following an internal fault of any magnitude.

28.3.2 Ratings

The capacitors shall have a nominal rating of 440V and shall clearly indicate the respective kVAr outputs on the exterior of the Capacitor at 400V and 415V.

28.3.3 Protection

a) Protected against internal failure by a three phase, tear off, fuse.
b) The capacitors shall be fitted with discharge resistors to IEC 70 (To be updated with latest Standard) to reduce the residual voltage to less than 50V within 60 sec. after being disconnected from the supply.

28.3.4 Switching

Each 3-Phase capacitor installed shall be individually switched via a suitable rated contactor, whether it is the total step or a portion thereof.

28.4 REACTIVE CONTROL RELAY

The flush panel mounted controllers shall be provided with a minimum of:-

a) Key operated, "Auto" "Off" "Manual" selector switch
b) Pilot light (multiple LED) indication for each set of capacitors in circuit.
c) Soft-touch keypad, integral with the controller, for accessing internal software and calling the various displays.
d) LED displays for alarms, operating values (such as VOLTS, AMPS, COS f, kVAr) and programme settings together with keypad adjustment for target and other set values. The display for each value shall be numeric.

[redacted]

e) Automatic set-up feature that shall locate the position of the CT equipment and investigate the installed capacitive and inductive devices together with their switching modes, before committing the data to memory, and arranging the set-up of the controller.

f) The set point for the target power factor shall be adjustable, at the keypad, in the range 0, 85 Lagging to 0, 95 Leading.

g) Self-diagnostic fault detection.

h) Alarms for loss of control system voltage and signals. (Controller inputs)

i) Indication of :-

j) Insufficient compensation available to achieve target power factor - the identity of the capacitor steps summoned.

k) The capacitive fields.

l) The mode of operation (Auto or Manual) for each capacitive step - the faults as they occur with date and time stamping.

m) The 3rd, 5th, 7th, 9th, 11th, and 13th harmonics, displayed as a % of the fundamental.

n) Target power factor.

o) Single phasing detection, with set identification.

p) Temperature of accommodation for capacitors and inductors.

q) RS 232 port for Up/Down loading of software and alarms to/from a laptop computer. Compatible with Modbus (or Modbus +) for future interfacing with SCADA system.

r) When the controller signals a contactor to close shortly after it has been opened, the contactor shall remain open until the capacitor potential has discharged to less than 50V.

28.5 CAPACITOR CONTACTORS

Contactors shall be selected from the categories listed in IEC SANS/IEC 60947-4-1 as follows:-

Category AC6b Switching of three phase capacitor banks and detuned capacitors.

Contactors selected from any category shall have an expected life of 1, 5 million operating cycles.

Only contactors with manufacturer's published kVA ratings shall be acceptable. Particular attention shall be given to any de-rating which may apply when switching capacitor banks.

Preference will be given for contactors specifically designed for capacitor switching in particular those contactors fitted with inrush limiting resistance, or inductances.

These inrush-limiting resistors shall be removed automatically from circuit once the main contactor poles have closed.

28.6 CONTACTOR BASES

Each capacitor step shall be supplied by one only triple pole HRC fuse base. For short circuit protection, bus-bar mounted fuse bases are preferred. A rating between 1.5 and 1.8 times the rated step current is required, and the fuses shall be of the slow-blowing type.

If contactors with inrush limiting resistors as detailed above are installed then the fuse rating may be reduced to 1.2 to 1.3 times the rated step current.

Connecting cables shall be designed for 1.5 times the rated current values.

28.7 INDICATOR LAMPS

Each capacitive step shall have a cluster LED green indicator lamp, energised via an auxiliary contact on the step contactor.

The appropriate panel cut-outs shall be provided in the system cubicle door to accommodate at least 2 additional steps.

28.8 CONTROL SWITCHES

28.8.1 Hand/Off/Auto switches

Hand/Off/Auto control switches shall be fitted to each capacitive step. The Hand position shall be wired to a phase other than that supplying the reactive relay.

28.8.2 Maintenance/Normal Switch

A 2-position maintenance/normal key switch shall be fitted and wired to prevent unauthorised switching of the capacitor steps i.e. in "normal" position the Hand/Off/Auto switches shall be electrically disconnected. The key shall be retained in the maintenance position, and be removed in the normal position. Indication of the modes of operation is also required.



29 CONTROL PHILOSOPHY

29.1 SCOPE OF WORK

The Control Philosophy to be employed for the operation of the plant is as described in the Project Specification. The proposed Control Philosophy shall be controlled by the proposed PLC as described in the Project Specification.

29.2 TYPICAL MODES OF CONTROL

Once a 'Stop' button has been pressed and the respective motor drive is stopped, it shall only possible to start the motor by first releasing the stop facility and then pressing the 'Start' button.

Each item of plant, as indicated in the Motor List and Control Schedules shall be provided with a

"Manual/Off/Auto" selector switch on its MCC cubicle door.

In "Manual" control, panel-front pushbuttons shall be provided for starting, stopping and control.

In "Auto" control, starting and stopping shall be via the PLC, with appropriate input from control instrumentation where applicable.

The Emergency Stop button shall be hard-wired to the respective equipment starter

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30 INCORPORATION OF AN ALTERNATOR/GENERATOR INTO AN INSTALLATION

30.1 NORMAL ELECTRICITY SUPPLY

The Supply Authority for the Area.

30.2 EMERGENCY ELECTRICAL SUPPLY

In the event of a power outage the proposed new standby alternator will be used to supply emergency power. The Contractor shall use the following as a guide to design and install control equipment that is of the latest technology in use.

a) The Contractor shall supply, install and commission a new standby alternator and diesel Prime-mover, designed to be installed within an ISO container. The prime power generator shall have a continuous (Prime) rated output in kVA, 400V, 50Hz supply and shall be suitable for use where equipment generates harmonics (FVD's, PC's, UPS's etc.). The waveform of the generator shall be sine wave shaped and have no distortion that may cause undue damage to electronic equipment that they will be supplying when in operation.

b) Generator output voltages shall not drop by more than 10% under worst-case step loading.

c) The proposed new standby generator shall start up automatically if a no volt situation is detected on the Municipal incoming supply.

d) Suitable automatic changeover equipment shall be supplied and installed.

e) When the Municipal/Eskom supply is re-established, the alternator circuit breaker shall open and the Municipal circuit breaker shall close.

30.3 DIESEL PRIME-MOVER

The Contractor shall supply, install and commission a new standby alternator and diesel Prime-mover, designed to be installed within an ISO container. The prime power generator shall have a continuous (Prime) rated output in kVA, 400V, 50Hz supply and shall be suitable for use where equipment generates harmonics (FVD's, PC's, UPS's etc.). The waveform of the generator shall be sine wave shaped and have no distortion that may cause undue damage to electronic equipment that they will be supplying when in operation.

Generator output voltages shall not drop by more than 10% under worst-case step loading.

The proposed new standby generator shall start up automatically if a no volt situation is detected on the Municipal incoming supply.

Suitable automatic changeover equipment shall be supplied and installed.

When the Municipal/Eskom supply is re-established, the alternator circuit breaker shall open and the Municipal circuit breaker shall close.

The alternator shall run for 5 minutes after the Municipal/Eskom supply has been reestablished before switching off.

a) The prime-mover shall be a diesel engine specifically designed for the purpose of driving a prime power generator at governed speed of 1500 - 3000 revolutions per minute.

b) The engine shall be freely available in the Republic of South Africa, including spares, servicing and workshop facilities.

c) The engine of the standby alternator set as supplied and installed shall be suitably rated to meet the requirements of this specification.

d) The exhaust gas temperature, measured in or on the manifold, shall not exceed the manufacturers stated limit, and in any case shall not exceed 500°C at 100% of the specified engine/alternator rating.

e) Turbo-charged engines will only be accepted provided the engine is designed and manufactured as such. The turbocharger shall be fitted with a heat shield if near any combustible material. Turbo-charged engines shall be suitably sized to meet the step load performance specified. Reaction time of the turbocharger shall not exceed the time specified in BS 5514, for class AO governing.

f) The Tenderer shall ensure that the manufacturer of the prime-mover shall provide the prime-mover intake and exhaust silencing, to ensure compliance with standards and specifications pertaining to the prime-mover considered. Should 'add on' silencing equipment be necessary for sound attenuation, then the 'add on' shall be to the approval of the manufacturer of the prime-mover.

Further to the above, the engine shall be provided with the following:

a) An enclosed flow, force feed lubrication system by a positive displacement type oil pump fed from engine oil sump.

b) A low oil pressure protection alarm.

c) Fuel and lubricating oil filters with replaceable elements and pressure by-pass.



d) An air-inlet manifold filter of the dry element type.

e) A fuel injection pump with a suitable governor, capable of controlling the engine speed in accordance with BS 5514 class AO.

f) A continuously rated fuel solenoid required for engine cut out. The control arm shall have only one knuckle joint and should an external spring be required it shall be anchored to a purpose made bracket.

g) A heavy-duty 26-volt charging alternator, regulator and batteries for engine starting. Battery shall be capable of at least 6 consecutive start attempts, each attempt at cranking calculate for duration of 5 seconds.

h) Provision shall be made to adequately protect the engine against failure of the cooling system (i.e. high temperature protection and alarm). '

i) "EMERGENCY STOP" button shall be fitted within the alternator control panel, affording maximum safety to the operators of the standby alternator set.

j) A rotary pump, with pipe, for the removal of the crankcase oil where oil is difficult to drain.

k) An acceptable over speed sensing device.

l) The engine shall be supported at the front by mounting brackets. An acceptable method of supporting the back of the engine in the event of alternator removal shall be supplied, such as loose mounting brackets.

m) The flywheel shall have a moment of inertia, which shall allow the cyclic irregularity of the set to fall within the limits specified by BS 5514 as amended and meet the specified performance. The flywheel shall be both statically and dynamically balanced.

n) The engine shall be fitted with the necessary devices to automatically protect the engine against low oil pressure, excessive temperature rise, etc. Further, suitable gauges shall be mounted on a suitable purpose made bracket, mounted within the prime-mover area, to afford visual inspection of the state of the standby generator set, operating parameters.

30.4 DIESEL PRIME-MOVER BATTERIES

The prime-mover batteries shall be deep charging lead acid type batteries. The Tenderer shall ensure that the batteries are rated for the application intended in this specification.

The batteries shall be mounted on free standing, corrosion resistant stand that shall be separate from the prime-mover, and allow for easy maintenance of all cells.

The battery stand shall incorporate a protective cover to prevent accidental contact with the battery terminals. The stand shall incorporate a cubicle to accommodate a hydrometer, which shall be provided with the unit.

30.5 DIESEL PRIME-MOVER BATTERY CHARGER

The electrical supply for the alternator when in standby mode shall be from the main distribution board within the ISO container for the charging of the diesel Prime-mover batteries.

Automatic battery charging equipment of the constant current, voltage, monitoring type, shall be provided in a compartment, within the DB board. The battery charging equipment shall be isolated, with sheet steel barriers, from the remainder of the equipment in the control board. When the battery voltage reaches a pre-determined high level, the charger shall be switched off, thus enabling the battery to discharge to a pre-determined lower point, whereupon the charger shall again be switched on.

The battery charger circuit shall incorporate a "boost charge" with a lock out key switch, thus ensuring only authorised persons have access to the "boost" facility.

In the event of a mains failure, the supply to the battery charger shall be arranged to change over to the standby power output when the diesel engine driven alternator set is switched to its load, thus obviating the necessity for a separate charging device mounted on the engine.

30.6 ALTERNATOR

Alternators shall have rated Prime Power outputs, 1500rpm, at 0,8 lagging power factor. The machines shall deliver a three-phase, four-wire 50Hz supply at 400 Volt and shall be suitable for powering Variable Frequency Controller equipment.

The alternator output voltage shall not drop by more than 15% under worst-case step loading.

The alternator/prime mover will be installed within a suitable ISO container mounted on a concrete base.



30.6.1 **Alternators shall meet the following requirements:**

a) Synchronous.
b) Operating at a speed of 1500 rpm.
c) The alternator shall be capable of delivering 115% of its continuously rated power output, on the site, for a minimum of 15 minutes at the rated voltage, without damaging the alternator or shortening the life span.
d) Seals shall be provided to prevent the lubricating grease from migrating along the shaft to the rotor windings. (Pre-sealed bearings will not be accepted).
e) Grease cups shall be provided for each bearing in readily accessible positions, even if this means remotely mounting the cups.
f) The shaft-mounted fan shall be fitted at the air intake end of the machine and preferably this shall be the non-drive end.
g) The exciter shall be of the brushless construction, inboard of the bearings, of three-phase full wave design with silicon rectifying diodes.
h) Insulation shall be non-hygroscopic, non-nutrient Class B on the exciter, Class F on the stator and Class H on the rotating pole pieces.
i) The alternator shaft shall be rolled steel. The rotating field pole shall be bolted to the shaft with all other rotating electrical components. This means that the shaft shall be free from electrical grounds on the shaft.
j) The alternator shall have the capability of permitting the measurement of the excitation voltage at rated speed. This voltage shall be obtainable under any load condition.
k) The rotating bridge assembly shall be mechanically constructed with glass cloth impregnated with an epoxy resin binder.
l) The alternator shall be 4-wire Y connected with all cable ends brought out to the terminal blocks in the alternator cable end box.
m) The feet shall have machined surfaces at the mounting rail positions for good axial parallelism and shall be designed to minimize noise and vibration transmitted to the bedplate.
n) The alternator shaft with its rotating equipment shall be dynamically balanced up to 25% over speed condition.
o) A heater shall be provided in the alternator, which shall be arranged to keep the machine warm, to prevent the ingress of moisture. The heater shall be energized whilst the machine is stationary and de-energized when the machine is operating.
p) Measures shall be taken to limit noise emission to an absolute minimum and to achieve this, use of a high efficiency-cooling fan may be necessary.
q) It should be noted that the electric load of the alternator will include harmonic load (i.e. up to 1MVA harmonic loading) which could be developed by the equipment being fed.
r) The components of the voltage regulator shall consist of semi-conductors, completely static and containing no electro mechanical relays or fuses. The regulator shall be of the solid-state electronic type. A circuit breaker for protection of the power circuit shall be provided with the voltage regulator.
s) Response time to changes in load shall be less than 10 milliseconds and shall maintain voltage regulation at 1% R.M.S., when:
t) Load varies between no load and full load
u) The power factor varies between 0,8 and unity
v) A speed change of up to 5% occurs
w) The regulator shall be capable of withstanding centrifugal forces from 20 to 500 Hertz.

30.6.2 **Alternator Licences**

The Contractor shall supply to the City Of Cape Town, Engineering and Asset Management branch, all original software licenses for any equipment installed and used for the control of the alternator.

30.7 **ALTERNATOR CONTROLS PANEL**

30.7.1 **Control Panel**

The Alternator Control Panel located within the container shall include the following:-

a) A "Deep Sea" controller (or similar) for the alternator supervision and control.
b) 3 x MDI ammeters, with selector switches.
c) 1 x Voltmeter, 0-500 V with 7-position selector switch.
d) 1x kW meter (Total Alternator kW).
e) E-stop.
f) Power and lighting distribution board with a suitable earth leakage unit.



g) Battery charger.
h) Cell phone modem.
i) Spare cubicle.

30.7.2 **Supply Power Changeover Switch**

The proposed control panel shall house a cubicle for the changeover equipment that will be used to select between two sources of electrical power, namely power from an external source, City of Cape Town's Electricity Department, or electrical power from the alternator. The changeover switches shall operate automatically if selected.

30.7.3 **Change - over circuit breaker**

The Contractor shall design control circuits that will allow for automatic change over from mains to alternator supply when the main supply fails. The alternator and main incomer circuit breakers shall be mechanically as well as electrically interlocked.

30.7.4 **Over current and short circuit protection**

The generator shall have one suitably rated main circuit breaker (moulded case) for generator main output circuit protection. The main circuit breaker shall be mounted within 300mm (max) of the generator output terminals and shall supply the generator change over switch installed within the generator ISO Containers or canopy.

Each alternator main circuit breaker shall be of such a design so as to allow for shunt tripping from any emergency stop switches, or the emergency stop situated in the alternator control panel.

30.7.5 **Starting and Stopping**

The engines shall be easily started from cold, without the use of any special ignition devices, under summer as well as winter conditions, against full load. To ensure easy starting in cold weather the engines shall each be provided with a thermostatically controlled 230-250 volt AC. electric immersion heater fitted to the water jacket. The electric circuits for these heaters shall be taken from the respective battery charger control board and shall be de-energised once the alternator has reached a 'steady state' output.

Circuit-breaker protection (with earth-leakage) is required for each immersion heater circuit.

The starting control for the prime-mover shall make provision for three consecutive start attempts of 10 seconds duration, each with 10 seconds rest periods in between. After a 3 minute rest period provision shall be made for a further three start attempts also of 10 seconds duration. If the prime-mover fails to start after these six attempts, the control circuit shall inhibit further start attempts until the reason for the failure to start has been traced and rectified, whereupon it shall be possible to reset the inhibiting device. When the set fails to start a visual alarm shall indicate the fault.

30.7.6 **E-Fuel**

The Contractor shall provide, within the generator control panel, a cubicle for housing E-Fuel equipment. The Cubicle shall measure minimum, W200mm x H200mm x D200mm. A 5A double pole CB shall be mounted in the top left hand side of the cubicle on suitable top- hat rail. Suitable sized galvanized steel conduit shall be installed from the cubicle to a position in close proximity of the fuel inlet feeder pipe. The conduit shall be installed in position to prevent any tripping or snagging on clothing of any operational/maintenance staff.

30.7.7 **Generator Water Heater**

The Contractor shall manufacture a 10 litre water heater reservoir from 304L stainless steel. The water heater reservoir shall have a 3kW dry element installed into a suitable heater pocket within or under the water volume to be heated.

The water heater reservoir shall have all hose connecting attachments match the existing water cooling system hoses. The water inlet must be at the lowest point of the reservoir and the outlet at the highest point, ensuring proper heat transfer. The design must ensure that no air is captured inside the reservoir.



30.7.8 Alarm Equipment With Indication And Trip Facilities

Any trip conditions shall be indicated on the alternator controller to allow easy visual identification of fault conditions and those alarms, which are annotated with the word TRIP shall incorporate facilities, which shall be arranged to stop the diesel engine driven alternator set.

The conditions shall include a minimum of the following:-

a) High engine temperature. [TRIP]
b) Low oil pressure. [TRIP]
c) Low cooling water level.
d) Low fuel level. [TRIP]
e) Excess electrical load on alternator. [TRIP]
f) Battery voltage low at starter motor cranking speed.
g) Failure of supply to engine immersion element.
h) Failure of supply to battery charger.
i) Start system inhibited (excessive start attempts).
j) Alternator output under voltage. [TRIP]
k) Alternator output over voltage. [TRIP]
l) Alternator output under frequency.
m) Alternator output over frequency. [TRIP]

All trip conditions shall not be resettable unless the fault has been cleared.

30.7.9 Additional Equipment

30.7.9.1 Alternator/Generator Monitoring System

Monitoring shall be done by MOD bus PLC remote monitoring. The unit should be easy to install (e.g din rail mounted). Prevention of equipment failure; meaning that early problem detections need to be made available or communicated to us. We would require the unit to manage our equipment in a way that it would make our fault finding on a unit simple and straight forward. The system should provide us with historic performance information for technical staff to analyse.

Communication should be done by Global System for Mobile Communication (GSM).

Monthly performance reports to be submitted.

The following parameters shall be made available through the GSM, All alarms mentioned under clause 31.7.8 shall be grouped under "Engine failure" for monitoring purposes.

30.7.9.2 Cell phone modem

A cell phone modem shall be supplied with the alternator set to inform operation staff, as to trip conditions and alternator set warning conditions.

The cell phone modem shall be installed in the alternator control panel.

An omni-directional aerial shall be mounted on top of the MDB and shall be connected to the cell phone modem via a RF extender cord.

The Water and Sanitation Department shall provide a SIM card for the omni directional cell phone modem.

Intrusion alarm

Low battery voltage (minimum 23 V for 24 V system and 11 V for 12 V system)

Engine Run

Engine Stop

Engine fail to start

Fuel level (%)

Battery charger failure [ALARM)

Generator controller operating mode: AUTO/REST/MANUAL

Low fuel parameter set to a minimum of 40 % tank level. [WARNING]



Main incoming supply ON/OFF

Generator supply circuit breaker OPEN/CLOSED

Generator running Ampere

Generator running Volts

Too many start attempts (ALARM)

The data shall be made available by incorporating it into the existing SCADA report dashboard viewed by the operations and EAM depots.

30.7.9.3 **Unit capability**

a) User to be able to select items to be monitored
b) Send stored data to a local server
c) Be able to export data into common file types
d) Large on board memory
e) Hardware package should be reliable

30.7.9.4 **Unit Specifications**

a) RS 232 or RS485 MODBUS communication with Deep Sea Electronics controller
b) Remote GSM communications to server for data delivery to off-site database
c) Internal SIM card
d) Internal storage memory for buffering of measured data during communication outages.
e) Live monitoring of relevant generator set controller registers and report error / alarm conditions via GSM if detected.
f) Ability to add software-based business rules to determine error / alarm conditions.

30.7.9.5 **GSM modem specifications:**

The Contractor shall supply RICA'd sim cards for the modems. The Contractor shall ensure completely operational systems, able to transmit all the alarm conditions as listed above, to the relevant COCT operational staff.

a) The modem should be of dual band type 900 Mhz/1800Mhz.
b) The modem should conform to the GSM standard with GPRS class 10 capabilities.
c) The Maximum Radio Frequency output power will be 2 watts for GSM 900 and 1 watt for GSM 1800. The data connection should be via RS232. The modem should be configurable using the AT command set. The operating temperatures should be between –20°C and + 55°C.
d) The following shall be monitored and transmitted via the cell phone modem:-
e) Low oil pressure
f) Generator Trip
g) UPS Trip
h) Low fuel level.
i) Main supply failure
j) Illegal access to generator (alarm activating devices on all doors)

30.8 **COOLING SYSTEMS**

The prime-mover shall be of the water cooled type and shall incorporate a built-on, heavy duty pattern, pressurised radiator, suitable for ambient temperatures up to 450 C. The cooling system shall be arranged to draw the air over the prime-mover and to force the cooling air through the radiator and into the duct which shall direct the air to the outside of the ISO container. Temperature sensing devices shall be provided which shall monitor temperatures in both the engine cooling and exhaust systems. The temperature monitors shall be provided with alarm and "shut down" features. The temperatures at which the alarms are set shall be adjustable within the range 85% to 98% of the value set for the temperature at which "shut down" occurs. The temperature at which "shut down" occurs shall be similarly adjustable but shall be set and sealed by the manufacturer. Should a high temperature be monitored, an alarm (both visual and audible) shall be provided. If the temperature continues to rise the alternator

Set shall automatically shut down when the "shut down" temperature setting is attained. Audible and visual alarms shall be indicated and enunciated when "shut down" occurs. The audible alarms, at all

[redacted]

levels, shall be provided with accept facilities but the visual alarms shall remain displayed until the cause is removed. All alarms and settings shall be provided on the control board.

30.9 LUBRICATION

Each lubrication system shall comprise:-

Protection shall be provided against low oil system pressure. This protective device shall shut down the engine and give a visual and audible indication on the control board. The detection system shall be manually reset before the engine may be re-started.

The Contractor shall provide details of the recommended lubricants specified by the manufacturer in the operation and maintenance manuals.

a) a self-lubricated, positive displacement gear driven oil pump with a pressure relief valve
b) full flow engine mounted oil filter of the replaceable element type equipped with an automatic by-pass valve (direct engine mounted no exposed oil lines)
c) full flow oil cooler with an automatic by-pass valve
d) pressure lubricated main, connecting rod, gudgeon pin, camshaft and rocker arm
e) spray oil cooled piston under crowns
f) Positive crankcase ventilation.
g) low engine oil level sensor

30.10 FUEL SYSTEM

The fuel system shall comprise:-

a) One base tank consisting of a polyethylene inner fuel tank and a 304 stainless steel safety outer tank (with filler pipe protected with vandal proof locking covers exterior).The safety tank shall have a sight glass for visual inspections of the polyethylene tank and for leaks that may occur. The safety tank shall have a stop-cock for draining any such leakages.
b) Anti-fuel theft device/s fitted to tank filler piping.
c) Manual, self-lubricated, positive displacement, gear driven fuel transfer pump requiring no adjustment
d) One primary and one secondary fuel filter of the replacement element type, and a water trap of the "Automatic" type or equivalent.
e) An approved water trap/traps.
f) An indicating fuel level gauge.
g) A low fuel level alarm giving an audible and visual signal on the control board. A cancel device for the audible alarm is required.
h) A drain cock/s shall be provided on the fuel tank/s to permit the tank/s to be drained and cleaned. The drain cock/s shall be fitted with a padlocking facility.
i) A visual fuel level indication (non electric or electronic)
j) Tank capacity for 12 hours uninterrupted operation, at the rated full load of the alternator.
k) The fuel tank shall be designed, constructed and installed in accordance with SANS 10131 "The Storage and Handling of liquid Fuel, Part II – 1979 Large Consumer Installations".
l) Exterior of tank to be painted with a suitable diesel resistant paint.
m) The capacity of the fuel tank/s shall be stencilled on the outside of the tanks.
n) The fuel tank/s shall be supplied with fuel filled to the tank/s full capacity.
o) E-fuel tagging together with all electrical connections needed.
p) Sufficient 304 stainless steel bunding tank with drain facility.

30.11 FUEL TANK

The fuel tank requirement is:-

a) Tank capacity for 12 hours uninterrupted operation, at the rated full load of the alternator.
b) The fuel tank shall be designed, constructed and installed in accordance with SANS 10131:2014 "The Storage and Handling of liquid Fuel, Part II – 1979 Large Consumer Installations".
c) Manufactured from 304 stainless steel plate.
d) Exterior of tank to be painted with a suitable diesel resistant paint.
e) Pad lockable arrangement for fuel cap (Tenderer to furnish details for approval).
f) The capacity of the fuel tank/s shall be stencilled on the outside of the tanks.
g) The fuel tank/s shall be supplied with fuel filled to the tank/s full capacity.



30.12 FUEL LEAK TEST

The fuel tank shall be tested for leaks prior to any paintwork that is to be undertaken and leak tests shall be witnessed by the Engineer.

30.13 FIRE DETECTION

A fire detector shall be provided and it shall be mounted above the diesel prime-mover. The fire detection sensors shall enable the alternator controller to automatically shut down the prime-mover and cut off all fuel supplies.

The fire detector signal shall be wired to the "Deep Sea" controller. In the event of fire within the container, the controller shall shut off the fuel solenoid.

30.14 ISO CONTAINER SPECIFICATION

30.14.1 General

Each container to be supplied and installed shall be a one-trip unit, with minimal damage. The Engineer shall approve the container prior to the Contractor placing any firm orders for the aforementioned. The Contractor shall rectify any defects on the ISO container at the Engineer's direction.

The Engineer shall witness progress of the painting and further painting will not be allowed until the required finishes are achieved.

All metal that has been drilled, ground with carborandum disks, welded or any other process that exposes steel to the atmosphere shall be painted with rust inhibitor/rust converting paints or epoxies.

No second hand containers will be accepted, the contractor shall only provide the City of Cape Town with new containers.

30.14.2 Each Container is to conform to the following:

Doors shall be lockable with a suitable door catch arrangement including a padlock cover for anti-vandalism.

One dry powder fire extinguisher shall be mounted within the container at the entrance double door. The fire extinguisher shall be easily accessible from the entrance double doors.

30.14.3 Signage

The Contractor shall fix the following notices (signage) to the exterior container walls in four of the official languages, viz English, Afrikaans, Xhosa and Zulu:

a) Warning of Auto start of Generator
b) Fire extinguisher location (red and white).
c) Fire extinguishers.
d) Danger of electrical shock (yellow and black).
e) Hearing protection (blue and white).
f) In the event of electrical shock – first aid steps for resuscitation of electrical shock victim.
g) First aid steps for burn victims.

Operating signs that are not safety related need only be in English.

30.14.4 Power and Lighting Requirements within each ISO Container

a) 4 x Bulkhead DC lights with a 15-minute timer.
b) 2 x AC 2 x 54W T5 fluorescent vapourlume lighting fittings.
c) 1 x 16A Single phase double socket outlet.

30.14.5 Lighting Circuit Arrangements

a) Four bulkhead lighting fittings, to be supplied by 24V DC shall be wired to a single lever switch, which is to be positioned at the entrance of the double door of the container. The DC lights shall be controlled by a timer set for one event for 10 minutes only repeated as necessary.
b) Four fluorescent lighting fittings to be supplied by 230V AC shall be wired to a single lever switch, which is to be positioned at the entrance of each container.

[redacted]

30.14.6 **Exhaust and silencing system**

All piping for the exhaust system shall be of grade 304 stainless steel. The silencers and all pipe support brackets shall also be of stainless steel.

The exhaust system, including silencers, shall be acoustically insulated with a preformed mineral wool inner layer sealed with asbestos free finishing plaster in order to satisfy the OHS requirements.

Exhaust outlets shall be fully protected against the ingress of rain.

The silencing system shall include a reactive silencer and an absorptive type silencer and all support brackets. A flexible connection of the bellows type shall be installed as close to the manifold(s) as possible to limit vibration transfer and to allow expansion under heating. The standard reactive (i.e. pulsation damper type) silencer shall be installed downstream of the flexible connection. The distance between the engine and the reactive silencer shall be designed to avoid resonance. An additional absorptive silencer, Burgess or equivalent, shall be installed downstream of the reactive silencer. The tail pipe shall have a length of at least 15 times the pipe diameter, measured downstream of the absorptive silencer.

Where the generator set is installed inside an enclosure or room, both silencers shall be installed inside the enclosure. The exhaust outlet shall be led outside the generator room to discharge at least 2, 5 metres above ground level.

30.14.7 **Sound Attention**

The prime-mover and alternator-combined noise level, when installed in a 6m ISO container shall not exceed 60 dba for residential areas and 65 dba and higher for industrial areas measured 7m from the container, at full load.

The sound attenuation louvres shall be manufactured from 304 stainless steel and be painted with a suitable type of paint that will bond onto the 304 stainless steel.

The Contractor shall notify the Engineer, prior to painting, to inspect and approve the attenuation louvres.

The contractor shall produce proof from his steel supplier to indicate the grade of steel supplied. The Contractor shall keep records to prove that the correct steel for the louvres has been used for manufacturing the louvres.

Sound attenuating materials that need to be supported/attached within the container interior walls shall be secured behind perforated 1,6mm thick, 10mm diameter perforation, 3CR12 steel sheets. The perforated sheets shall be supported by a method that hides the support system. All joins of the 3CR12 sheets as well as all corners where sheets meet shall be finished off with aluminium 2mm thick aluminium flashing.

The Contractor shall submit detailed drawings with his Tender Offer.

30.14.8 **Painting**

30.14.8.1 **Surface preparation for ISO container:**

Once all cutting and welding work is fully completed, the Contractor shall shot blast the entire container. The Contractor shall notify the Engineer to inspect the shot blasting results, prior to staring any of the following applications:

Stripe coat all edges, welds, edges and crevices with Opti Mastic AL Red Toned.

Coatings need to be washed down between coats with clean potable running water, allow drying and then painting.

The bottom support members of the container floor and also the entire roof section to be spray painted using rubberised spray paint (Polyurethane), to prolong the life span of the corrosive environment exposed areas.

a) Optima Industrial Coating Specification (or equivalent) for external steel sections:

Coat	Product Name	Generic Type	V/S %	DFT Min	DFT Max
Primer	Opti Mastic AL	High Build Epoxy Mastic	92	125	175
Finish	Opti Thane 421	Gloss Polyurethane	50	50	75

Coatings need to be washed down between coats with clean potable running water, allow drying and then painting.

[redacted]

b) Optima Industrial Coating Specification (or equivalent) for internal steel sections:

Coat	Product Name	Generic Type	V/S %	DFT Min	DFT Max
Primer	Opti Mastic AL	High Build Epoxy Mastic	92	125	175
Finish	Opti Thane 421	Gloss Polyurethane	50	50	75

Stripe coat all edges, welds, edges and crevices with Opti Mastic AL Red Toned. Coatings need to be washed down between coats with clean potable running water, allow drying and then painting.

c) Optima Industrial Coating Specification (or equivalent) for **galvanized steel sections**:

All surface preparation and application shall be in accordance with the relevant product data bulletin, this specification, and the general painting specification of Optima Coatings and SANS 1200. If a conflict exists between the above items, the most restrictive shall be considered the control.

Ensure surfaces are not left overnight to prevent contamination from resettling on the surface and all bare exposed metal surfaces to be coated within the 4 hour window period.

Only Optima thinners and reducers as identified in the appropriate product data sheet shall be used.

Optima Industrial Coating Specification for galvanised sections:

Remove all traces of protective storage oil by scrubbing with Optima Opti-Degreaser followed by thorough rinsing with potable running water (use hose pipe) to obtain a water break-free surface. If necessary, repeat above until water break-free. Follow this by scrubbing with Optima Galvanize iron cleaner and rinsing with potable running water. Allow to dry before priming

Coat	Product Name	Generic Type	V/S %	DFT Min	DFT Max
Primer	Opti Mastic AL	High Build Epoxy Mastic	92	125	175
Finish	Opti Thane 421	Gloss Polyurethane	50	50	75

Stripe coat all edges, welds, edges and crevices with Opti Mastic AL Red Toned.

All surface preparation and application shall be in accordance with the relevant product data bulletin, this specification, and the general painting specification of Optima Coatings and SANS 1200:2014. If a conflict exists between the above items, the most restrictive shall be considered the control.

Only Optima thinners and reducers as identified in the appropriate product data sheet shall be used.

30.15 SPARE PARTS

The Contractor shall ensure that the supplier of the prime-mover considered for the alternator shall be able to supply any spare parts within 24 hours of placing an order for spare parts should the need arise at a later date after the defects notification period has expired. Refer data sheets delivery times.

31 POSITIONS

The Engineer shall approve final positions and arrangements of all equipment forming part of this contract.

32 REDUNDANT EQUIPMENT

All equipment made redundant during work on City of Cape Town's Plant contract shall be listed in writing and made available to the Engineer who shall provide final confirmation as to what equipment may be scrapped by the Contractor. The City of Cape Town reserves the right to retain any equipment made redundant for use on this or other plants under its control.

33 FINISHING AND PAINTING OF MATERIALS AND EQUIPMENT

All equipment and materials supplied under this Contract, irrespective of whether it is for the electrical subcontract or not, shall comply with City of Cape Town's specifications.

The painting and finishing specifications are detailed in the General Mechanical Specification, and the onus is on the Electrical Contractor to familiarise with these specifications

[redacted]

34 OPERATION AND MAINTENANCE MANUALS

34.1 SUBMISSION OF MANUAL

Three draft copies of the Manual shall be submitted to the Engineer prior to commissioning the Works. One copy will be returned to the Contractor with comments. The second copy will be used by the operational staff on Site.

Six copies of the final version of the Manual, as accepted by the Engineer, shall be provided prior to the start of the Defects Notification Period.

34.2 GENERAL REQUIREMENTS

The Manual shall comply with the following:

a) The Manual shall be for the complete Works and shall be of a standard acceptable to the Engineer. It shall be in English and shall be practically and neatly presented.

b) One Manual shall contain original documents and this set shall be marked "Original". The other 5 Manuals shall contain all the information in the original and shall be marked "Copy 2" to "Copy 6".

c) Binders shall have hard, plastic protected covers utilizing four-ring, spring-clip holders. Binders shall not be overloaded. One spare, empty binder shall be provided for every three used. A title label shall be affixed to the spine of all binders. This shall indicate Contract number, title, Contractor's name, Site/Plant name, volume number and contents.

d) Sections and sub-sections shall be titled, uniquely numbered and provided with separator sheets.

e) Printed matter which is inserted in the Manual shall be arrowed (indelibly) to indicate the equipment installed.

f) Drawings shall be to a scale which makes details clear. Large drawings shall be held in plastic envelopes in the Manual. A4 and A3 drawings may be bound as normal pages. Drawings shall also be provided on electronic data storage in AutoCAD, or equivalent, format.

g) Location map, street address as well as GPS co-ordinates to be provided.

h) Cross-referencing within the Manual is acceptable where duplication occurs.

34.3 FORMAT AND CONTENTS

The Manual shall be in accordance with the following (the Contractor shall modify, elaborate and repeat this format as required):

34.3.1 Electronic Format

All information in the hard copy O&M manuals to be provided in soft copy on a USB flash discs (x6) with separate folders for each section including all material related to the particular section. Each section shall be saved as a separate PDF file, with a hyperlinked index sheet for subsections. This shall include drawings and maintenance schedules as separate files. In addition, the "Summary equipment and maintenance template" shall be saved in Excel format under Section 1. Contractor to ensure the latest Excel template is requested, used and completed.

All necessary software programs and passwords to be provided.

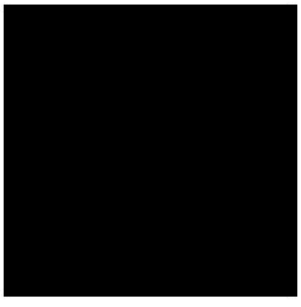
No.	HEADING	CONTENT
1	GENERAL	
1.1	Contents List	Contents List for complete Manual.
1.2	Description of the Works	The description of the Works shall include a description of; firstly, the process; secondly, the design parameters and; thirdly, a detailed description of the equipment installation supported by drawings and process flow diagrams.

[redacted]

No.	HEADING	CONTENT
1.3	Equipment List	Equipment list containing each item of mechanical, electrical, instrumentation and control equipment. The equipment list shall include the make, model, serial number, description, size, range, performance data, motor and drive details, supplier's name, address and phone numbers, all as applicable. The design duty, the position of each unit's installation and its purpose in the system shall be given. Additional information which shall be provided for instruments includes the normal operating reading, maximum or minimum permissible readings, set-points (activation, warning and trip), etc. A separate list of all spares provided in terms of this Contract shall also be provided.
1.4	Drawing List	Drawing list of all the Contractor's drawings and the Tender drawings.
1.5	Cable Schedule	Cable schedule for power, data, control and instrumentation cables. This shall include the cable construction, conductor material, insulation, protection, voltage rating, start and finish points, route length, duty, load, voltage drop, core area, no. of cores, no. of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.
1.6	Documents	As-built system, layout and GA drawings. Plant circuit, flow diagrams and/or P&IDs. Control panel layouts. I/O list, program listing, loop and logic diagrams for each PLC. Colour prints of SCADA mimic screens, control faceplates and sequences. System control diagram and logic sequence chart. Copy of certificate of electrical compliance.
2	OPERATION	
2.1	Control System	Description of control system; including all manual and automatic controls. This shall include controls, instruments, protection list, settings, indications, alarms, trips, etc.
2.2	Commissioning	Commissioning Instructions. Commissioning report.
2.3	Operating and Training Manual	Operating and training manual. This shall include normal start-up, adjustment, operating and shut-down procedures and any emergency operating procedures. All specific safety aspects as well as settings, adjustments, observation, etc. shall be provided.
3	MAINTENANCE SCHEDULES	
	Maintenance and Lubrication	Schedule of routine maintenance, by time period, for all mechanical, electrical, instrumentation and control equipment. This shall be all-inclusive but reference to manufacturer's standard manuals in other parts of the Manual is acceptable. The schedule shall incorporate a lubrication schedule of recommended lubricants, capacity, lubrication periods, etc.
4	MECHANICAL EQUIPMENT	
	(This section shall be repeated for each item of equipment)	
4.1	Identifying Information	Identifying information for the item; copied from the Equipment List.
4.2	Nameplate	A photograph of the nameplate and a table containing the unit's nameplate information.
4.3	Design and Operation	Details of operating principles, construction and operating instructions.

[redacted]

No.	HEADING	CONTENT
4.4	Maintenance Information	Technical and maintenance information including instructions for Installation, assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.
4.5	Spares	A spares list giving the item number, part number, description, quantity and materials. A list of spares recommended to be held on Site.
4.6	Test Results	Factory and Site test results.
4.7	Corrosion Protection	Corrosion protection systems used, coating supplier's data sheets and coating repair procedures.
4.8	Documents	Performance curves. Large scale, dimensioned, cross sectional and arrangement drawings of the item for assembly and spares recognition purposes, cross-referenced to the spares list. Dimensioned drawings of fabricated equipment. Circuit layout of any auxiliary systems
5	ELECTRICAL EQUIPMENT	
	(This section shall be repeated for each item of equipment)	
5.1 to 5.6	As for 4.1 to 4.6 for Mechanical Equipment (see above).	
5.7	Control Details	Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.
5.8	Documents	Electrical reticulation drawings. Equipment overall dimensions. Wiring diagrams. Switchboard layout drawings and SLDs. Electrical panel construction drawings.
6	INSTRUMENTATION EQUIP.	
	(This section shall be repeated for each item of equipment)	
6.1 to 6.6	As for 4.1 to 4.6 for Mechanical Equipment (see above).	
6.7	Documents	Circuit diagrams of instrumentation systems and of individual instruments. Installation arrangement.
7	CONTROL EQUIP.; ETC.	
7.1	Identifying Information	Identifying information for PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.
7.2	I/O List	Cross-referenced listing of all I/Os used.
7.3	SCADA	Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.
7.4	Program	Flash disk containing all software. An annotated program listing.
7.5	Documents	Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.
8	DRAWINGS	
	Drawings	All drawings not filed elsewhere shall be filed in this section.



35 STARTING, SITE TESTING AND COMMISSIONING OF PLANT

35.1 GENERAL

The Contractor shall advise the Engineer when instructions may be given to the Building Contractor to execute any necessary screeding and finishings around the Works. Tenderers shall allow a reasonable period in their installation programme for this work to be done and no compensation for delay in the commencement of testing and commissioning shall accrue to the Contractor during such period.

35.2 PREPARATION

Installation work shall be complete and accepted by the Engineer prior to commissioning.

Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start with safety. The Contractor shall provide initial fill requirements, such as lubricating oil.

35.3 STARTING UP AND TESTING

The Contractor shall arrange for the Engineer to be present at initial start-up and also for any electrical and control instrumentation sub-contractors to be present.

The Contractor shall start up and test each section of the Works. These tests shall be carried out to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Engineer. All necessary modifications and rectifications shall be carried out during this period.

Set points for equipment and process parameters which are required for the operation of control systems shall be confirmed and recorded.

35.4 SCADA SYSTEM

During commissioning of a new installation which incorporates SCADA as part of the control system, each control system alarm and interlock shall be tested and the resulting alarm messages shall be modified by the Contractor to be acceptable to the Engineer.

A schedule of alarm messages and their full explanations shall be inserted in the Manual.

35.5 COMMISSIONING

When all tests have been completed to the satisfaction of the Engineer, the Works shall be commissioned. Unless the Engineer states otherwise, the complete plant, including all control functions and control systems shall be commissioned as a unit and the process performance requirements shall be achieved during normal operation.

Once the Works has been commissioned to the satisfaction of the Engineer, the operational acceptance period shall start and shall consist of a continuous period of operation free from trouble. Unless otherwise stated, this period shall be four weeks. During the operational acceptance period, the Contractor shall carry out all necessary servicing and any adjustments required. The plant staff will assist the Contractor in operating the Works during this period. The Contractor shall train the operational staff in the starting, operating and stopping of the Works, and shall train the maintenance staff on the routine maintenance requirements.

35.6 COMMISSIONING REPORT

A comprehensive commissioning test report, including the SCADA system commissioning procedure and schedule of alarm messages, shall be submitted by the Contractor prior to issue of the Certificate of Completion and shall be inserted in the Manual.

The contractor shall provide the following performance reports: for commissioning and tests as said above, a report after month of commissioning, report after three, six and 12 months of commissioning.

35.7 INSPECTION

At the end of the Trial Operation Period, an inspection shall be done by the Contractor and the Engineer for the purpose of taking over the Works in terms of Clause 10 of the General Conditions of Contract.

35.8 DEFECTS NOTIFICATION PERIOD

Refer to Clause 11 of the General Conditions of Contract and the Detailed Mechanical Specification for requirements regarding maintenance during the 365 day Defects Notification Period.



Reactive and proactive maintenance performed shall be captured by the Contractor and confirmed by the Senior Engineer. This communication shall be done in the following format:

Date
Plant name
Location and GPS
Equipment reference / what failed
What is the damage
Causes of the damage
Repair time

36 SPARES AND TOOLS

At completion of the work, before commissioning, the Contractor shall submit for approval by the Engineer, a full list of the spares that he intends providing.

Where specific spares are recommended by the supplier or manufacturer, these shall be included in full in the list for approval.

Generally, spares shall include the following:

a) LV fuses: 1 spare for every 2 installed.
b) Indicator lamps: 1 spare for every 10 installed.
c) Lamp lenses: 3 spare for each colour installed
d) Push buttons: 1 spare for every 3 or less of each colour and type installed.
e) Lamps of luminaires: 1 spare for every 10 or less of each type installed.

Any special tools required to perform routine maintenance on any specific item of equipment shall be provided under this contract. Contractor or tenderer must provide list of recommended spares- refer datasheet of spares

37 EQUIPMENT APPROVAL

The Contractor shall submit detailed working drawings of all boxes, boards, panels, brackets, trays, etc. to the Engineer for approval prior to manufacture. The drawings shall be not less than A2 and shall clearly indicate the principal dimensions and at least two cross sections shall be provided. Door and cover plate details shall be given, together with details of hinges and catches. The work may not proceed until the drawings have been properly scrutinised and approved.

38 SCHEDULE OF EQUIPMENT

A complete list of fittings and other equipment intended for use on this Contract is to be submitted with the tender. This list shall contain manufacturers' names, catalogue numbers, etc. Where any item offered is not to specification, prior approval in writing shall be obtained from the Engineer before this can be offered.

Should any item supplied not comply with the specification, an alternative which meets the specification is to be approved by the Engineer and provided at no additional cost to the Contract.

39 EQUIPMENT TO BE SUPPLIED AND INSTALLED

The Engineer reserves the right to call for samples of the equipment offered, to inspect the workmanship as the work proceeds and to either accept or reject the equipment, or workmanship. The Engineer's approval of the design, materials and workmanship shall in no way reduce the Contractor's liability to provide a complete and proper working plant which is abreast with modern technology.

All such samples may be retained until completion of the Contract. All such samples shall have securely attached thereto labels designating the Contract by name and number (if any), the name of the Contractor and any further relevant information.

Unless where specified and agreed to IN WRITING, all equipment supplied by all parties shall be new and unused.

40 EVERYTHING NECESSARY

The Contractor will be deemed to have visited the site and to have satisfied himself as to the nature of the work, to have acquainted himself with any limitations which may be imposed upon him and to have



provided for any additional costs which he may consider necessary for the proper completion of the work. No claim will be recognised or considered after submission of price on the grounds of lack of knowledge of site conditions or limitations.

The installation shall include everything necessary whether specified in detail or not and shall be carried out in the best possible way to ensure a complete and first class installation to the approval of the Engineer.

41 UNIFORMITY

All items of the same type of equipment shall where at all possible - be of the same make and type for each item throughout the installation, to ensure interchange ability and ease of maintenance.

42 RADIO, TELEVISION, COMPUTER AND COMPUTER SYSTEM INTERFERENCE

The Contractor shall allow for interference suppression components where required, to ensure that the electrical installation shall not cause interference to radio, television, staff location, computer and computer systems.

43 DELIVERY

The Contractor must co-ordinate the delivery dates for all items of equipment supplied by him to allow adequate time for installation, commissioning and testing prior to contract completion.

To this end, the Contractor must ensure that shop drawings are presented to the Engineer for approval timeously, and a programme of submission of such drawings must be approved by the Engineer as specified in the Conditions of Tender.

Documentary proof is to be supplied of the placing of all orders for equipment having a protracted delivery period. No substitution of specified items will be allowed due to the late placing of orders, and no delay claims in this regard will be entertained.

44 CONTRACTOR'S STAFF

The work shall be done by, or at all times be under the personal supervision of an installation electrician appointed in writing by the Contractor as the Responsible Person, in terms of the requirements of the Machinery and Occupational Safety Act. This person shall be available during working hours, and shall be experienced in projects of the specified.

The Engineer may, if he deems fit, require that the Contractor removes or causes to be removed an employee of his from the specified premises by virtue of that person's incapability, appearance or any such reason which in the opinion of the Engineer, is valid.

At all times while on the specified premises, all artisan and labourer members of the Contractor's staff shall wear clothing adequately marked with the Contractor's name or acceptable identification.

45 VARIATIONS

For the purpose of determining the cost of individual variations the Tenderer shall quote scheduled rates which would be accepted as a basis for the evaluation of extras and omission.

46 INSPECTIONS, TESTS, MEETINGS AND COMMISSIONING

46.1 GENERAL

Should any tests or inspections be required outside of the Cape Metropole Area, the Tenderer shall allow in his Tender price for all costs (travel, accommodation, subsistence, etc.) for minimum of two persons to attend such tests or inspections.

The fact that the plant and equipment has satisfactorily passed any test made at the Subcontractor's works shall in no way lessen the responsibility of the Subcontractor to obtain the same results after it has been delivered and erected permanently on site.

46.2 TESTS

The Contractor shall notify the Engineer at least 2 weeks in advance, should his presence be required for inspections or witnessing of tests.



46.3 **INSPECTIONS**

Works acceptance (function) tests shall be performed, which shall be witnessed by the Engineer and the Client or the Engineer's representative.

In the event that tests fail, the Contractor shall be required to perform such tests again. Should these test require the Engineer to be present again, the Engineer's cost for time and travel shall be recovered from the Contractor at rates as set out by the South African Association of Consulting Engineers.

All test certificates required in terms of the current SANS regulations shall be furnished before the project can be completed. These shall also be bound into the operating and maintenance manuals.

46.4 **MEETINGS**

It is expected that the Contractor will be represented at every Project meeting during the contract. Meetings will be held in two formats, Site meetings and Technical meetings. The Site meetings will be held monthly, and it is expected that the Subcontractor be represented by a senior person in the Subcontractor's firm, who can act on behalf of the Subcontractor.

At the Technical meetings, held between the Site meetings, the Subcontractor's representative may be a site or contracting foreman who is technically competent, having only to receive instructions on behalf of the Subcontractor.

The Subcontractor shall make provision in the pricing of his Preliminary and General costs for these meetings.



47 APPENDIX A

NO#	Drawing Description	Drawing No.
1	Typical Meranti Trench Cover	EAM-EE-GS-001
2	Details of Transformer & RMU Slab Showing Reinforcement	EAM-EE-GS-002
3	Typical Trench Layout	EAM-EE-GS-007
4	Field Control Station for Push Buttons	EAM-EE-GS-008
5	Field Control Station for Push Buttons - "Type B"	EAM-EE-GS-009
6	Field Control Station for Push Buttons - "Type C"	EAM-EE-GS-010
7	MV Switch Rooms: Trench Floors & Outline Dimensions	EAM-EE-GS-011
8	Ultrasonic Wet Well Hatch - Core-Drilled	EAM-EE-GS-012
9	Crane Supply DB	EAM-EE-GS-013
10	Standard Power & Lighting Distribution Board	EAM-EE-GS-014
11	Typical Outdoor DB	EAM-EE-GS-015
12	Typical MCC Rating Plate	EAM-EE-GS-016
13	Lamp & Push Button Colours	EAM-EE-GS-017
14	Typical 400V Free Standing Switch Board(MCC) Requirements	EAM-EE-GS-018
15	Typical Starter Door Layout	EAM-EE-GS-019
16	General Arrangement of MV Power Factor Correction Panel	EAM-EE-GS-020
17	Typical Instrument & Marshalling Panel	EAM-EE-GS-021
18	Typical Power Factor Correction Panel	EAM-EE-GS-022
19	Substation Enclosure & Transformer Earthing	EAM-EE-GS-023
20	Typical Details for a 5m x 7 740m Substation Enclosure	EAM-EE-GS-024
21	Typical MV Equipment Labelling for Substation	EAM-EE-GS-025
22	Typical MV Equipment Labelling for Mini-Substation	EAM-EE-GS-026
23	Details for a 3 5m x 5m Transformer Enclosure	EAM-EE-GS-027
24	Transformer & RMU Slab Details	EAM-EE-GS-028
25	LV Voltage Change Over Arrangement	EAM-EE-GS-029
26	Typical MV Differential Protection Arrangement	EAM-EE-GS-030
27	Typical LV Starter Panel Schematic 230VAC/24VDC Control	EAM-EE-GS-031
28	Typical MV Power Factor Arrangement (Schematic)	EAM-EE-GS-032
29	Wiring Diagram Template	EAM-EE-GS-033
30	Typical Scada Control Desk	EAM-EE-GS-034
31	Typical Layout of MV Indoor Switchgear Panel Arrangement	EAM-EE-GS-035
32	Fibre Optic & MV Cable Trench Arrangement	EAM-EE-GS-036
33	Typical Cable Draw Pit	EAM-EE-GS-037
34	MV Busbar & Cable Earthing Arrangement	EAM-EE-GS-038
35	Typical LV Incomer Arrangement	EAM-EE-GS-039
36	Typical Generator Connectivity Box	EAM-EE-GS-040



NO#	Drawing Description	Drawing No.
37	Fire Station Lighting	EAM-EE-GS-041
38	Typical Exterior Lighting Control Circuit	EAM-EE-GS-042
39	Typical Duct Cross Section	EAM-EE-GS-043
40	Substation Doors - Solid & Louvered	EAM-EE-GS-044
41	Typical Steel Door 1x800 Type A	EAM-EE-GS-045
42	Typical Steel Door 1x800 & 1x400 Type B	EAM-EE-GS-046
43	Typical Steel Door 1x800 & 1x400 Type B2 with Louvres	EAM-EE-GS-047
44	Typical Steel Door 2x800 Type C	EAM-EE-GS-048
45	Typical Steel Door 2x800 Type C2 Extended Height	EAM-EE-GS-049
46	Typical Steel Door 2x800 Type C3 with Louvres	EAM-EE-GS-050
47	Ultrasonic Wet Well Hatch	EAM-EE-GS-051
48	Typical Pump Station Junction Box	EAM-EE-GS-053
49	Typical General Arrangement 75kW Pumps Local Starter Panel	EAM-EE-GS-054
50	Typical Pepper Spray Stainless Steel Box	EAM-EE-GS-055



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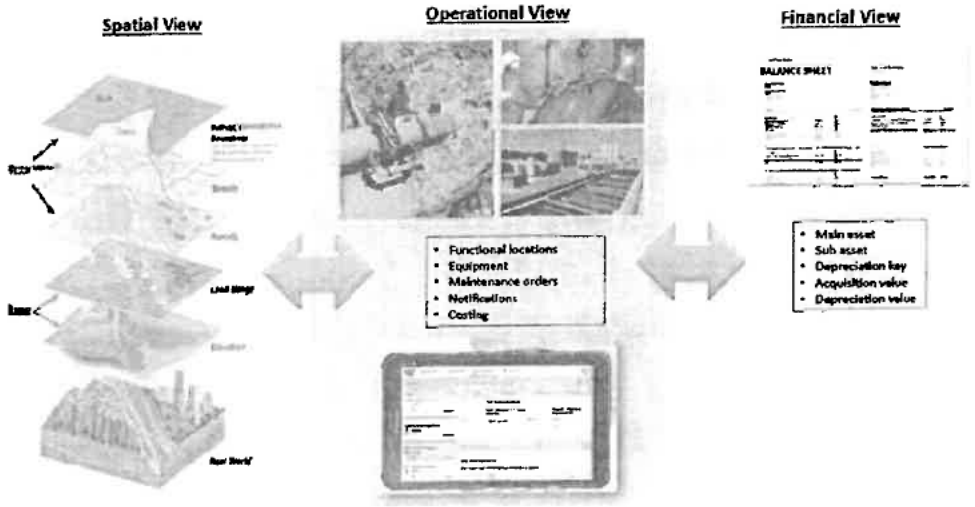
Asset Management 40

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Introduction

The Plant Numbering System consists of a Functional Location structure to identify the physical location of technical objects in a process plant or facility and a unique number for each maintainable technical object within the Water and Sanitation Department.

This document describes the W&S infrastructure master data standards for the operational view. Along with the related master data processes (e.g. new assets, asset modification and assets disposal) and systems developed (e.g. GEO.e) this provides the master data governance designed to ensure a core of accurate infrastructure master data across the 3 main asset information views: Spatial (GIS), Maintenance (SAP PM) and financial (SAP FI-AA):



Purpose

The purpose of the Plant Numbering System procedure is to provide a uniform structure from which unique functional location codes can be generated for technical objects.

The Functional Location code number is essential for identifying technical objects for operational, maintenance and safety procedures.

Cost and maintenance history data is captured on each functional location code and maintainable object for reporting and maintenance optimisation purposes. This is achieved with the aid of the computerized maintenance management system, SAP Plant Maintenance.

[redacted]

Linear vs Non-Linear assets

The Water & Sanitation department manages their asset master data in two distinct categories, "linear" and "non-linear" assets. Linear assets refer to network and associated assets which are typically managed spatially (e.g. a pipeline and a valve that is part of a segment of pipeline). Non-linear assets normally refer to a facility, e.g. a Water treatment works which assets are logically structured in a hierarchy as explained in this document.

Linear Assets	Non-linear assets
• Typically, a continuous/network asset with a start and end point with associated assets • Underground/not easily visible • Require GPS co-ordinates / spatial view to locate • Exists in GIS system with attributes, limited master data information in SAP PM • Examples: Pipelines and their associated assets e.g. hydrants, valves, etc. • Asset creation/edit/disposal is initiated in the GIS system utilising ESRI Collector, As-built drawings and Field surveys • Linear SAP PM Mask: WA AAAA-NNNNNN or WA-AAAA-NNNNNN/AAANN (when assets installed) • As-built drawings linked via GIS Engineering search tool	• Typically, at a facility that can/is enclosed and exists on a single erf • Can be easily located (street address) • Exists as a point/polygon in GIS representing all assets that forms the facility • Exists in detail in SAP PM, with detailed transactional history per asset • Examples: treatment works, pump stations, reservoirs, dams at Level 4 and as individual pieces of equipment (e.g. pump) at level 7. • Asset creation/edit/disposal is initiated in the SAP PM system utilising equipment template and conversion program • Non-Linear SAP PM Mask: WAAAAA-NNAANN-AAANN-XXXNN • O&M Manuals and documentation managed via DMS

[redacted]

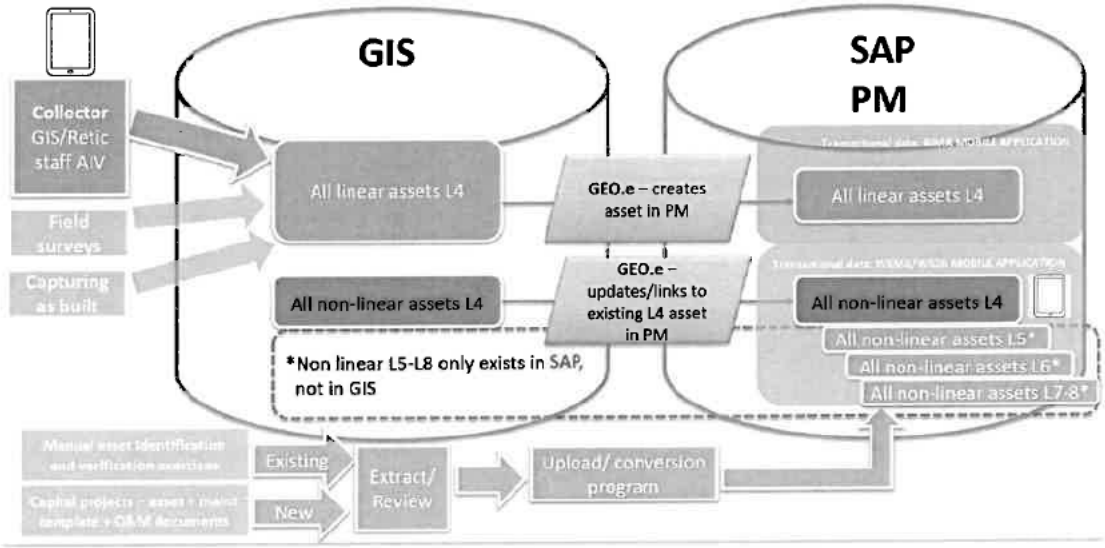
GEO.e

GEO.e is a tool that consists of a synchronisation framework between GIS and SAP as well as a visualisation layer inside of SAP. The tool and related business processes has been configured to align with the relevant data custodians based on a "linear" or "non-linear" classification.

Linear Asset creation/edit/disposal is initiated in the GIS system utilising ESRI Collector, As-built drawings and Field surveys. GIS master data stewards is ultimately responsible for the data.

Non-linear asset creation/edit/disposal is initiated in the SAP PM system utilising equipment templates and conversion programs. SAP PM (CMMS) master data stewards is ultimately responsible for this data.

High level information flow between GIS / SAP via GEO.e for Linear and Non-linear assets:



[redacted]

Asset groupings and key integration fields which forms part of the synchronisation framework (GEO.e) between ESRI GIS and SAP is as per below:

Grouping	GIS FS	GIS Published FC	Cat. Type	SAP Object Type	L3 FLOC	Financial Asset Class
Sewer Network	Pressurised Mains	SL_SWR_MAIN_PRS_SYNC	Linear	ZW_R_X_PLP	WR-XPLP	13100
	Gravity Mains	SL_SWR_MAIN_GRVT_SYNC	Linear	ZW_R_X_PLG	WR-XPLG	13100
	Manhole	SL_SWR_MNHL_SYNC	Linear	ZW_R_X_MNH	WR-XMNH	13100
	Pump Stations	SL_SWR_PUMP_STN_SYNC	Non-Linear	ZW_R_X_PSS	N/A	13400
	Valve	SL_SWR_VLV_SYNC	Linear	ZW_R_X_VLV	WR-XVLV	13100
	Treatment Plant	SL_SWR_TRMN_PLNT_SYNC	Non-Linear	ZW_R_W_TRP	N/A	13300
	Final Effluent Outfalls	SL_SWR_FNL_EFLN_OTFL_SYNC	Linear	ZW_R_X_PLO	WR-XPLO	13200
Water Network	Pressurized Main	SL_WTR_MAIN_SYNC	Linear	ZW_R_W_PLN	WR-WPLN	16400
	Reservoirs	SL_WTR_RSRV_SYNC	Non-Linear	ZW_R_W_RSV	N/A	16500
	Pump Station	SL_WTR_PUMP_STN_SYNC	Non-Linear	ZW_R_W_PSX	N/A	16600
	Valves	SL_WTR_VLV_SYNC	Linear	ZW_R_W_VLV	WR-WVLV	16700
	Water - Zone Management Stations	SL_WTR_ZONE_MNG_STN_SYNC	Non-Linear	ZW_R_W_PMS	N/A	TBC
	Hydrants	SL_WTR_HDRN_SYNC	Linear	ZW_R_W_FEX	WR-WFEX	16400
	Network Meters	SL_WTR_NTWR_MTR_SYNC	Linear	ZW_R_W_MTR	WR-WMTR	16100
Bulk Water	Bulk Water - Well Fields	SL_WTNK_BULK_WLFL_SYNC	Non-Linear	ZW_W_W_PLW	N/A	16500
	Water Treatment Works	SL_WTNK_BULK_TRTM_PLNT_SYNC	Non-Linear	ZW_W_W_TRP	N/A	TBC
	Bulk Water Catchment Areas	SL_WTNK_BULK_CTCH_AREA_SYNC	Non-Linear	ZW_W_W_CAA	N/A	21110
	Water Supply Dams	SL_WTNK_BULK_DAMS_SYNC	Non-Linear	ZW_W_W_DAM	N/A	16500
	Bulk Water Aquifers	SL_WTNK_BULK_AQFR_SYNC	Non-Linear	ZW_W_W_AQU	N/A	16500
	Bulk Water Reservoir	SL_WTNK_BULK_RSRV_SYNC	Non-Linear	ZW_W_W_RSV	N/A	16500
	Bulk Water Boreholes	SL_WTNK_BULK_BRHL_SYNC	Non-Linear	ZW_W_W_BOR	N/A	16500
	Aquifer Recharge Pond	SL_WTNK_BULK_AQFR_RCHR_POND_SYNC	Linear	ZW_W_W_ARP	WW-WARP	16500
	Aquifer recharge line	SL_WTNK_BULK_MAIN_AQFR_RCHR_SYNC	Linear	ZW_W_W_ARL	WW-WARL	16200
	Well Field Collector Lines	SL_WTNK_BULK_MAIN_WLFL_SYNC	Linear	ZW_W_W_WCL	WW-WWCL	16200
	Bulk Water - Valves	SL_WTNK_BULK_VLV_SYNC	Linear	ZW_W_W_VLV	WW-WVLV	16200
	Bulk Water Pump Stations	SL_WTNK_BULK_PUMP_STN_SYNC	Non-Linear	ZW_W_W_PSB	N/A	16600

[redacted]

	Bulk Water Main	SL_WTNK_BULK_MAIN_SYNC	Linear	ZW_W_W_PLB	WW-WPLB	16200
	Bulk Water Meters	SL_WTNK_BULK_MTR_SYNC	Linear	ZW_W_W_MTR	WW-WMTR	16100
	Bulk Water - Network Components	SL_WTNK_BULK_NTWR_CMPN_SYNC	Linear	ZW_W_W_NTC	WW-WNTC	16200
Spring Water	Springs	SL_WTNK_SPR_SYNC	Linear	ZW_C_C_SPR	WC-CSPR	16500
	Mains	SL_WTNK_SPR_MAIN_SYNC	Linear	ZW_C_C_PLP	WC-CPLP	16400
	Pump Stations	SL_WTNK_SPR_PUMP_STN_SYNC	Non-Linear	ZW_C_C_PSP	N/A	16600
	Valves	SL_WTNK_SPR_VLV_SYNC	Linear	ZW_C_C_VLV	WC-CVLV	16700
	Spring Water Reservoirs	SL_WTNK_SPR_RSRV_SYNC	Non-Linear	ZW_C_C_RVS	N/A	16500
	Network Components	SL_WTNK_SPR_NTWR_CMPN_SYNC	Linear	ZW_C_C_NTC	WC-CNTC	16400
Treated Effluent	Mains	SL_WTNK_TE_MAIN_SYNC	Linear	ZW_R_T_PLT	WR-XPLT	16400
	Pump Stations	SL_WTNK_TE_PUMP_STN_SYNC	Non-Linear	ZW_R_T_PST	N/A	16600
	Reservoirs	SL_WTNK_TE_RSRV_SYNC	Non-Linear	ZW_R_T_RSV	N/A	16500
	Network Components	SL_WTNK_TE_NTWR_CMPN_SYNC	Linear	ZW_R_T_NTC	WR-XNTC	16400
	Valves	SL_WTNK_TE_VLV_SYNC	Linear	ZW_R_T_VLV	WR-XVLV	16700
	Collection Points	SL_WTNK_TE_CLCT_PNT_SYNC	Linear	ZW_R_T_CLP	WR-XCLP	16400
Buildings	Depots & Workshops	SL_WTNK_DPTS_WRKS_SYNC	Non-Linear	ZW_B_W_WHP	N/A	31210
	Staff Housing	SL_WTNK_WS_STAFF_HSNG_SYNC	Non-Linear	ZW_B_W_HSG	N/A	31850

Financial Integration

Integration with the finance module is achieved through linking SAP PM technical objects (functional locations) to Asset numbers from the FI.AA module. The FI.AA module is used to generate financial statements and includes data fields like Book Value, Acquisition Value, Expected Useful Life (EUL), Remaining Useful Life (RUL) and Depreciation. The custodians of this data is from Corporate Finance. For linear assets a finance key is generated automatically to create a shell for grouping financial assets per type per suburb. For non-linear assets a template is utilised which aligns the SAP PM technical objects at Level 6 (complex asset) to the relevant asset class and type so that financial assets can be created by the Finance data stewards and linked to the the applicable complex asset.

[redacted]

Functional Locations

A Functional Location represents the place at which a maintenance task is to be performed. It is used to structure the maintenance objects according to functional, process-related or spatial criteria.

- Functional – Pump Station, Treatment Plant, Reservoir, ...
- Process – Primary Treatment, Secondary Treatment, Conveyance (Pumping), ...
- Spatial – Area, Floor, Room, ...

Purpose of Functional Location

- Execution of maintenance tasks.
- Recording of maintenance tasks.
- Equipment installation and monitoring.
- Data collection over long periods of time.
- Cost/History monitoring by Function, Process, Spatial Area.

For Water and Sanitation, a combination of the above structuring is used, and this is represented as the Coding Structure.

[redacted]

Functional Location Coding Structure Summary

The Functional Location Coding Structure consists of an eight-level hierarchical structure.

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

Level 1 – Business Level:

Identified by One Alpha character. It denotes the Service within the Directorate, i.e., W for Water & Sanitation Services.

Level 2 – Branch

Identified by One Alpha character. It indicates the Branch, e.g., X for Wastewater, R for Reticulation and W for Bulk Water.

Level 3 – Site/Location Code:

Identified by Three Alpha characters. It is used to uniquely identify each of the following type of Sites/Locations:

- Bulk Water and Wastewater treatment plants and reservoirs.
- Over 500 Reticulation pump stations and network tank reservoirs.

Level 4 – Site/Facility Type:

Identified by One Alpha character. It indicates the Main type of Facility on the Site. It is thus also possible that one Site/Location can have many different Facilities. This level is also maintained in the GIS system, with the lower levels (5-8) of non-linear assets only existing in SAP.

Level 4 Naming convention for pumpstations: "Facility Name"+"(optional alt name)"+facility type"+"-"+(opt Medium)", e.g. "Alf (Stinkgat) - Pumpstation (Sewer)"

Level 5 – Process Area:

Identified by Two Numeric characters. This defines the Process Area which will be found within a Process for a Plant or Facility

Level 6 – Complex Asset or Asset Grouping:

Identified by Two Alpha characters, followed by Two Numeric characters. Some assets are seen as Complex Assets as it forms a "Unit" via the combination of various assets. Some minor assets are also grouped into logical groups at this level.

A Grouping of Physical Assets which together form a Complex Asset. (Examples: Aerator Unit/System; Building, Pumpline set etc)

[redacted]

A Complex Asset can be procured as a Capital item, but normally not replaced in totality.

A Group of Assets is a Logical Grouping of Physical Assets to provide better hierarchical structuring. (Examples: Fire Fighting Equipment; Lights, Etc.). The financial unit of account for new assets recorded in the SAP financial module is set at Level 6 for non-linear assets.

Level 7 – Asset:

Identified by Three Alpha characters, followed by Two Numeric characters. It identifies the unique asset. An asset either forms part of a Complex Asset or it is just grouped into an Asset Grouping. An Asset is normally of Capital nature (i.e. it is not a spare component). An Asset has independent physical or functional identity and specific attributes, such as different life expectancy, maintenance and renewal requirements and regimes, risk or criticality.

Level 8 – Instrument:

Identified by Three characters, followed by Two Numeric characters. It identifies the unique instrument. Instruments are always related to a specific Asset.

Functional Location - Example:

The Functional Location **WWPVVT-77PS01-PMP01-VT_01**, can be interpreted as follows:

W	: Water & Sanitation
WW	: Bulk Water
WWPVV	: Voëlvlei
WWPVVT	: Treatment Plant
WWPVVT-77	: Reservoir Supply Pumping
WWPVVT-77PS01	: Pump Line System 1
WWPVVT-77PS01-PMP01	: Pump, Pump Line 1
WWPVVT-77PS01-PMP01-VT_01	: Vibration Transmitter Pump 1, Line 1

[redacted]

Reference Functional Locations

Reference Functional Locations do not represent technical systems but are solely for the purpose of acting as a template for the real Functional Locations.

A Reference Functional Locations exist in SAP that uniquely identify the following:

- Level 5 Functional Locations
- Allowed Level 6 Functional Locations for each Level 5 Functional Location
- Level 6 Functional Locations
- Allowed Level 7 Functional Locations for each Level 6 Functional Location
- Level 7 Functional Locations
- Level 8 Functional Locations

All real Level 5, Level 6, Level 7 and Level 8 Functional Locations must be linked to a Reference Functional Locations.

Should new values be required, the Reference Functional Locations must be updated in SAP.

Numbering Rules

When allocating numbers on the sixth, seventh and eight levels the following rules must be adhered to:

1. Tag numbers increase with the direction of flow.
2. Count from left to right, facing downstream with the direction of flow.
3. Count from bottom to top, facing downstream with the direction of flow.

The Position Number field on the Functional Location is used to indicate the "order" of all the Functional Locations under a superior Functional Location. Values 10, 20, 30, 40, etc must be used.

Equipment

Identified by Nine Numeric characters. It is only used in the following scenario's:

- When the asset or instrument is managed as a rotable item, it is created as an Equipment and it is then linked on a one-to-one relationship with the Functional Location.
- Test Instruments and tools.
- Workshop Equipment.
- Small Plant and Vehicles.

[redacted]

Data Transfer for Functional Locations

The table below indicates which fields on a Functional Location must be populated at which level. All fields below should just inherit. Inheritance should only be broken in specific and documented cases.

FIELD	REFLOC	Data Origin (Maintain at this level)	Responsible
Company Code		W (Level 1)	Once off
Controlling Area		W (Level 1)	Once off
Business Area		W (Level 1)	Once off
Sales Organization		W (Level 1)	Once off
Distibution Channel		W (Level 1)	Once off
Division		W (Level 1)	Once off
Maintenance Plant		W (Level 1)	Once off
Maintenance Planning Plant		W (Level 1)	Once off
Location		W+++++ (Level 4)	From GIS via GEO.e
Plant Section		W+++++ (Level 4)	From GIS via GEO.e
Room Number		W+++++-++++++(Level 6)	AIV/Template (CMMS)
ABC Indicator	Y	From Refloc only at Level 6	
Sort Field		W+++++-++++++(Level 6)	AIV/Template (CMMS)
Asset Number		W+++++-++++++(Level 6)	Finance
Cost Center		W+++++ (Level 4)	From GIS via GEO.e or Manually by CMMS
Standing Order		n/a	
Settlement Order		n/a	
Authoriztion Group		n/a	
Construction Type		n/a	
Work Center		W+++++-++ (Level 5)	CMMS
Maintenance Catalog	Y	From Refloc only at Level 7	
Maintenance Planner Group		W+++++ (Level 4) (Maintain STS manually)	From GIS via GEO.e or Manually by CMMS
WBS Element		n/a	
Address		W+++++ (Level 4)	? Save GPS co-ordinates to Name 2 field of address

Tag Numbers

The Functional Location number of the Level 7 Asset is used without the Digits of the 1st four Levels for use of physical labels on site and coding SCADA and PLC Systems. The Tag Number for Pump no.1 for the functional location: **WWPVVT-77PS01-PMP01** is thus **77PS01-PMP01.**

The Tag Number for the Vibration reading on Pump no.1 originating from the vibration transmitter on Pump 1 with the functional location **WWPVVT-77PS01-PMP01-VT_01** is thus **77PS01-PMP01-VT_01**

The SCADA system must also have the first 4 levels (e.g. WWPVVT in above example) as the unique code for every plant/facility when data is extracted/presented for analysis.

[redacted]

Functional Location Coding Structure Details

This section will detail all allowable values for all 8 levels of the functional location structure.

1st Level identifier (Directorate)

Identified by One Alpha character. It denotes the Service within the Directorate, i.e., W for Water & Sanitation Services.

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

W	Water & Sanitation Services

2nd Level identifier (Branch)

Identified by One Alpha character. It indicates the Branch, e.g., X for Wastewater, R for Reticulation and W for Bulk Water.

	Business Level	**Branch Level**	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

B	Water & Sanitation Head Office
H	Water & Sanitation Housing
R	Reticulation
W	Bulk Water
X	Wastewater
Y	Scientific Services
Z	Engineering & Asset Management

3rd Level identifier (Site)

[redacted]

Identified by Three Alpha characters. It is used to uniquely identify each of the following type of Sites/Locations:

- Bulk Water and Wastewater treatment plants and reservoirs.
- Over 500 Reticulation pump stations and network tank reservoirs.

	Business Level	Branch Level	**Site Level**	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	**AAA**	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

Code	Description	Code	Description
PAS	Albion Springs	PAT	Athlone
PBB	Bloekombos [Sewage]	PBH	Blackheath Pump Station
PBH	Blackheath Water Treament Plant	PBL	Brooklands
PBQ	Bordcherds Quarry	PBV	Bellville
PCB	Campsbay	PCF	Cape Flats
PCN	Constantia Nek	PFA	Faure
PFI	Firlands	PFK	Fisante Kraal WWTW
PGB	Gordon's Bay	PGD	Garlandale
PGG	Glen Garry Reservoir	PGG	Glen Garry
PGP	Greenpoint	PHB	Houtbay
PHG	Helderberg	PHP	Hospital
PKD	Kildare	PKF	Kraaifontein
PKI	Plattekloof Instrumentation	PKL	Klipheuwel
PKN	Kloofnek	PLD	Llandudno
PMB	Melkbos	PMB	Melkbos
PMC	Macassar	PML	Midlands
PML	Miller's Point	PMO	Molteno
PMP	Mitchells Plain	PMR	Monterey
PNL	Newlands	PNL	Newlands. PPA = Philadelphia
POK	Oudekraal	PPD	Potsdam
PPK	Plattekloof	PPK	Plattekloof
PPL	Atlantis	PPL	Pella (Atlantis)
PPR	Parow- Plant Decommissioned	PRS	Riviersonderend
PSB	Steenbras	PSB	Steenbras
PSD	Scottsdene	PSS	Silwerstroom
PST	Simonstown	PTB	Tygerberg
PTB	Tygerberg	PTM	Table Mountain

[redacted]

PVV	Voelvlei	PWB	Wynberg
PWD	Wallacedene	PWF	Westfleur
PWH	W/Hoek	PWH	Wemmershoek
PWV	Wildevoelvlei	PWZ	Witzands
PZV	Zandvliet	QAA	Alf - Pump Station
QAB	Aurora - Pump Station	QAC	Alma Road Subway - Stormwater
QAD	Andrag	QAE	Botterblom
QAF	Atlantic Rd Main Sewer - Pump Station	QAG	Atlantic 1 - Pump Station
QAH	Atlantic 2 - Pump Station	QAI	Auckland Street
QAJ	Ascot village	QAK	Arum avenue
QAL	Alex Pienaar	QAM	Almeria
QAN	Airport Park 2	QAO	Airport Park 1
QAP	Absa	QAQ	Airport Park 3
QAR	Airport Park 4	QAS	Berkley Road Subway - Stormwater
QAT	Amic	QAU	Admiral Bierman
QAV	Avonwood - Pump Station	QAW	Area K
QAX	Area L	QAY	Alphen Sewage - Pump Station
QAZ	Klein Constantia Nek	QBA	Balvenie - Pump Station
QBB	Bloekombos Water	QBC	Beaconvale 1 - Pump Station
QBD	Betsie Verwoerd Pump Station	QBE	Beroma - Pump Station
QBF	Brackenfell (booster) Water	QBG	Brighton
QBH	Blackheath (Wimbledon)	QBI	Bergvliet
QBJ	Blomtuin - Pump Station	QBK	Boston 2 - Pump Station
QBL	Bakoven Tank	QBM	Brick and Clay Reservoir
QBN	Boston 1- Pump Station	QBO	Bosbou - Pump Station
QBP	Steenbras Intake Valve Chamber	QBQ	Bantry Court
QBR	Beach Road	QBT	Blomtuin Depot
QBU	Belletuin	QBV	Big Gates
QBW	Bongweni - Pump Station	QBX	Belhar 1 - Pump Station
QBY	Belhar 2 - Pump Station	QBZ	Belhar 3 - Pump Station
QCA	Bill Bezuidenhout Pump Station	QCB	Campsbay
QCC	Broadway 1 - Pump Station	QCD	Broadway 2 - Pump Station
QCE	Belloy	QCF	Concourse 1
QCG	Bishop Lavis 1 - Pump Station	QCH	Bishop Lavis 2 - Pump Station
QCI	Bishop Lavis 3 - Pump Station	QCK	Big Bay 2
QCM	Carlisle Street	QCN	Constantia Nek
QCO	Century City Main	QCP	Cayman Beach
QCR	Business Park 1 - Pump Station	QCS	Business Park 2 - Pump Station
QCT	College Road	QCU	Charles Hoffe
QCV	Century View	QCW	Carol road
QCX	Cavalry cresent	QCY	Clifton Road

[redacted]

QCZ	Clovelly (Sewer)	QDA	De La Rey - Stormwater
QDB	Crossroads	QDC	Decrest
QDD	Diep River	QDE	De Bron Water
QDF	Dalebrook	QDG	Dagbreek {Water}
QDH	Dalebrook chalet	QDI	Die kom 17
QDJ	Da Gama Park	QDK	Dennegeur
QDL	Dennehoek	QDM	Dumonte
QDN	Du Noon (Old)	QDO	Denovo - Pump Station
QDP	Disa Rd (Princess Street)	QDQ	Gordons Bay No.4
QDR	Draper Street Subway - Stormwater	QDT	Drommedaris 2
QDU	Danie Uys - Pump Station	QDV	Khayelitsha
QDW	De Waal - Pump Station	QDX	De Grendel {Water}
QDY	Constantia Nek Top	QDZ	Drommedaris 1
QEA	Eksteen (Loevenstein)	QEB	11th avenue (Zeekoevlei)
QEC	8th avenue	QED	Elfindale
QEF	Effluent (Old Plant)	QEG	16th avenue
QEH	Eastern High Level	QEI	Erf 1
QEJ	Erf 2	QEK	Bizweni
QEL	Strand (Waterkloof)	QEM	Clovelly (Water)
QEN	Erinvale	QEO	Dido Valley Lower
QEP	Dido Valley Chlorinator	QER	Elsies River
QES	Langa	QET	Eersterivier
QEV	Everite {Water}	QEW	Raapenberg
QEX	Ranger Road 2	QEY	Rietvlei
QEZ	Simonstown 1 (Longbeach)	QFA	Belhar Internal
QFB	Fish Hoek High Level	QFC	Freezia
QFD	Flintdale	QFE	Filters
QFF	Simonstown 3 (Jubilee Square)	QFG	Simonstown 11(Dido)
QFH	Victoria Road (Houtbay)	QFI	Belhar CBD
QFJ	Fisher Monger	QFK	Sunset Park
QFL	Baden Powell	QFM	Pelican Park 1
QFR	Fistante Kraal 5 MAIN - Pump Station	QFS	Fistante Kraal 1 - Pump Station
QFT	Fistante Kraal 2 - Pump Station	QGA	Gideon Basson 2
QGB	Glamise Close Stormwater	QGC	Golf course (Parow)
QGD	New Pelican (Zeekoevlei)	QGE	Grebbe
QGF	Goolhurst	QGG	Glen Garry {Water}
QGH	Golf Park 9	QGI	Golf Park 10
QGJ	Golf Park 11 A	QGK	Golf Park 12
QGL	Golf Park 14	QGM	Golf Park 4
QGN	Golf Park 5	QGO	Golf Park 7
QGP	Gordons Bay Road	QGQ	Golf B

[redacted]

QGR	Gie Road 1	QGT	Golf Park 8
QGU	Glen Beach	QGV	Glen cairn heights
QGW	Glenwood - Pump Station	QGX	Great Dutch
QGY	Grey Road	QGZ	Good Hope Centre
QHA	Harold Ashwell Rd	QHB	Houtbay Harbour
QHC	Harrington Street	QHD	Helderrand
QHE	Heinz Park	QHF	Heideveld
QHG	Helderberg College Road	QHH	Hout Bay Heights(Bayview)
QHI	Pinelands Hockey Fields	QHJ	Helderberg
QHK	Hardekraaltjie (Sportsfield)	QHL	Hillcrest
QHO	Hillary Close	QHP	High Press (G/Bay)
QHR	Henly road	QHV	Hendrik Verwoerd 1,2
QHW	Heron Waters	QIA	Imhoff park 15
QIB	Constantia Meadows	QIC	Coniston park
QID	Cliford road	QIE	Compass 11
QIF	Curlew road	QIG	Miles road
QIH	Melville road	QII	Milkwood park
QIJ	Melkhout cresent	QIK	Mount Rhodes
QIM	Section 10	QIN	Section 12
QIO	6th avenue	QIP	Sand river
QIQ	Silvermine village	QIR	Sea scouts
QIS	Silver Glade 7	QIT	Bokmakierie
QIV	Swaanswyk Lower	QIX	Swaanswyk Top
QIZ	Coen Steytler	QJB	Bakkerskloof
QJD	Jonkersdam - Pump Station	QJE	Civic Centre A1 - Stormwater
QJF	Civic Centre F7 - Stormwater	QJG	Civic Centre G4 - Stormwater
QJH	Coen Steytler 2 (Car Park) - Stormwater	QJI	Concourse 2 - Stormwater
QJJ	Coronation Road - Stormwater	QJK	Sybrand Park - Stormwater
QJL	Camp Road Subway - Stormwater	QJM	Mowbray Station Subway - Stormwater
QJN	College (Myrtle) Road Subway -Stormwater	QJO	Molteno 1
QJP	Molteno 2	QJQ	Molteno 3
QJR	Jan van Riebeeck	QJS	Jan Smuts
QJT	Civic Centre C6	QJV	Joe Slovo Drive
QJZ	Dennehof	QKA	Kapteins Baai
QKB	Koeberg Rd	QKC	Klip road
QKE	Kerkie - Pump Station	QKF	Kraafontein
QKG	Kalk bay chalet	QKH	Kelvin Grove Subway - Stormwater
QKI	Kenridge 1,2	QKJ	Kirsten road
QKK	Kenilworth Park	QKL	Keyser river
QKM	Kannemeyer	QKN	Kloofnek
QKO	Kuilsriver Golf Club Pump Station	QKQ	Koggelfontein

[redacted]

QKR	Kuilsrivier	QKS	Karl Bremer 1 - Pump Station
QKT	Karl Bremer 2 - Pump Station	QKU	Koggelfontein Sump
QKV	Kleinvlei	QKX	Clifton 1
QKY	Clifton 3	QKZ	Clifton 4
QLA	Langeberg	QLC	Lupin Crescent
QLD	Llandudno 1	QLE	Langa Minor
QLF	Liesbeeck Subway - Stormwater	QLH	Lavender Hill
QLK	Luchannon Drive	QLL	Lagoon No. 1
QLM	Lower Mountain Side	QLN	Lynn's View
QLO	Lagoon Mouth	QLP	Low Press (G/Bay)
QLR	Lourens rivier	QLS	Long Street
QLU	Louis Botha Ave	QLV	London Village
QMA	Montana - Pump Station	QMB	Mosterts Bay
QMC	Macassar	QMD	Mamre North
QME	Messaries - Pump Station	QMF	Mfuleni - Pump Station
QMG	Killarney Pump Station (Workshop)	QMH	Mamre South
QMI	Maidens Cove	QMJ	Metro
QML	Millers Point (Reservior)	QMM	Modderdam - Pump Station
QMN	Matopo Road	QMO	Mosselbank
QMQ	Murdock valley	QMR	Montclair
QMS	Mc Donalds - Stormwater	QMT	Millers Camp
QMU	Mnandi Beach	QMV	Mountain View Pump Station
QMW	Monwabisi	QMX	Mount Rhodes Reservior
QMY	Mc Carthy Pump Station	QMZ	Muizenberg
QNA	Nassau - Pump Station	QNC	North shore
QND	Narina avenue 18	QNE	Neptune
QNF	New Market Street	QNG	Nooitgedacht - Pump Station
QNH	N1 Pond - Stormwater	QNI	Newfields Estate
QNJ	Naomi Street	QNL	Newlands Lower
QNM	Melkbos Village 1	QNO	Nooiensfontein
QNP	Northpine - Pump Station [Sewage]	QNS	Narcissus Rd
QNT	St Andrews GW1	QNU	Turnberry Close GW2
QNV	Dennegeur	QOA	Oakdale - Pump Station
QOB	Open Tank 1,2	QOC	Sarel Cilliers
QOD	Da Gama Street	QOE	Dune Park
QOF	Clifton Top Tank	QOG	Clifton Lower Tank
QOK	Oudekraal	QOM	Old Mountainside
QON	Borehole	QOO	Old Oak - Pump Station
QOP	Ou Skip Caravan Park	QOR	Oostenberg
QOS	Ouskip	QOT	Sunset Rock
QOV	Oceanview Reservior	QOZ	Oranjezight

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QPA	Parklands	QPB	Palm Site
QPC	Paarden Eiland	QPD	Penhill
QPE	Parade Chalets	QPF	Pelican place 13
QPG	Pelegrini	QPH	Philadelphia (water)
QPI	Pop-In	QPK	Plattekloof - Pump Station
QPL	Pella 1	QPM	Perlemoen
QPO	Pelican Park 2 (Baden Powell)	QPP	Phoenix Park
QPQ	Queens Beach	QPR	Pinelands High School Subway
QPS	Patterson Tanks	QPT	Price Drive
QPU	Prince George	QPV	Piet My Vrou
QPW	Philippi East	QPX	Phillippi East 4.1
QPY	Phillipi West	QQA	Century City - Shopping Centre East
QQB	Century City - Shopping Centre West	QQC	Sandpiper Crescent
QQD	11th Avenue	QQE	Die Bad Pad
QQF	Strand Street [1]	QQG	Strand Street [2]
QQH	Marconi Beam	QQI	Sandrift East (Toilets)
QQJ	Sandrift Screws	QQK	Sanlam Park
QQL	Silwerstroomstrand 1	QQM	Silwerstroomstrand 2
QQN	Silwerstroomstrand 3	QQO	Silwerstroomstrand 4
QQP	Summer Greens	QQQ	Sunset Beach 1
QQR	Sunset Beach 2	QQS	Sunset Beach 3
QQT	Sunset Beach 4	QQV	Sunset Beach 5
QQX	Sunset Links 1	QQY	Sunset Links 2 (North)
QQZ	West Beach (Sandown)	QRA	Rosebank 5 Subway - Stormwater
QRB	River Booster	QRC	Race Course No. 1 Pump Station
QRD	Red Cross	QRE	Rocklands
QRF	Rugby (Brooklyn Chest)	QRG	Rondevlei
QRH	Royal Observatory	QRI	Retreat ext. 13
QRJ	Retreat low lift	QRK	Raapkraal
QRL	Retreat main	QRM	Ranger Road 1
QRN	Riverton - Pump Station	QRO	Reo - Pump Station
QRP	Royal Road	QRQ	Ranger Road Upper
QRR	River Road	QRS	Redhill squatters
QRT	Rosebank 3 - Stormwater	QRU	Rosebank 4 Subway - Stormwater
QRW	Ruwari (water)	QRX	River Inlet (Belongs to Bulk Water Faure
QRY	S.West - Rome Glen(New)	QSA	Stinkgat
QSB	Salt River	QSC	Silwerboom
QSD	Kleinvlei (Melton Rose)	QSF	Serepta 1 - Pump Station
QSG	Serepta 2 - Pump Station	QSH	Sea Point Pavillion
QSI	Site B - Pump Station	QSJ	Neil Hare
QSK	Schaap Kraal Depot	QSL	Stikland - Pump Station

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QSM	Spine Road	QSN	Sonskyn Reservoir
QSO	Stadler	QSP	Sea Point Tank
QSQ	Table View - Sprigg Road	QSR	San Michelle
QSS	Smuts Ave	QST	Simonstown -BlueWaters
QSV	Strandfontein Pavillion	QSW	Simonstown 13
QSX	Saxon Sea Nr 4	QSY	Parow Subway - Stormwater
QSZ	Sprigg rd	QTA	Timour Hall
QTB	Tafelberg Road	QTC	Tokai
QTD	San Michelle Sump	QTE	Tambo Street
QTF	Thibault Square	QTG	Tiger - Pump Station {Water}
QTH	Tygerhof	QTL	Tollgate
QTN	Town Ends - Pump Station	QTP	Tidal Pool
QTR	The Ridge	QTV	Table View East
QUB	Uxbridge	QUM	Upper Mountain Side
QUS	Sir Lowry`s Pass	QUT	Uitsig - Pump Station
QVA	Vorster avenue	QVB	Verbena - Pump Station
QVC	Fish hoek 1	QVD	Fish hoek 2
QVE	Fish hoek 3	QVF	Fish hoek 5
QVG	Fish hoek 8	QVH	Suikerbossie
QVI	Vukuzenzele	QVL	Valhalla - Pump Station
QVP	Victoria Palms	QVQ	Bikkini Beach
QVR	Van Riebeeck	QVT	Fish hoek 6
QVU	Fish hoek 9	QVW	Verwoerd - Pump Station
QVX	Fish hoek 10	QVZ	Victoria (Reservior) - Kendal Rd
QWA	Weltevreden Park	QWB	Wynberg
QWC	Woodstock	QWE	Wesbank
QWF	Wingerd	QWG	Table View West
QWI	Woodbridge Island Inn	QWJ	Woodbridge Island Out
QWK	Welgemoed 1 - Pump Station	QWL	Welgemoed Golf - Pump Station
QWM	Welgemoed Pump Station	QWN	Welgedacht - Pump Station
QWO	Woodville	QWP	W.P.Park - Pump Station
QWQ	Westlake 1	QWR	Wrench Rd Subway - Stormwater
QWS	Warwick Square - Stormwater	QWT	Wellington
QWU	Wildeboom	QWV	Westlake 2
QWX	Westlake New	QWY	Westerdale {water}
QWZ	Witzands	QXA	Marina da Gama 1
QXB	Marina da Gama 2	QXC	Marina da Gama 3
QXD	Marina da Gama 4	QXE	Marina da Gama 5
QXF	Marina da Gama 6	QXG	Marina da Gama 7
QXH	Marina da Gama 8	QXI	Marina da Gama 9
QXJ	Marina Da Gama 10	QXK	Simonstown 4

[redacted]

QXL	Simonstown 4a	QXM	Simonstown 6
QXN	Simonstown 7	QXO	Simonstown 5
QXP	Simonstown 8	QXQ	Simonstown 9
QXR	Simonstown 10	QXS	Simonstown 12
QXT	Simonstown 14	QXU	Simonstown 15
QXV	Simonstown 16	QXZ	Suikerbossie Reservior
QZA	Zirilder park	QZD	Brakkloof
QZE	Scarborough	QZF	Cullinan Street - Stormwater
QZK	Zandkloof - Pump Station	QZL	Kuilsriver - Zevenwaght lower
QZU	Kuilsriver - Zevenwaght upper (Booster)	QZW	Zevenwaght (Reservior)
QZX	Racecourse	QZY	Chapmans Peak no 1
QZZ	Pinehaven	RAA	Southfield Road Subways - Stormwater
RAB	Tiverton Road Subways	RAC	Piers Road Subways - Stormwater
RAD	Simonstown 2	RAE	Macassar 1
RAF	Louis Botha Ave 3_Resevior	RAG	Louis Botha Ave 1
RAH	Earth Dam	RAJ	S.West - Radloff (CMC)(Raw water)
RAK	S.West - Radloff (CMC)(clean Water)	RAM	G.Bay - Old Mountainside 1
RAP	Old Mountainside 2(out of use)	RAQ	Old Mountainside 2(out of use)
RAR	Ryger street (out of use)	RAS	Victoria road (Southfield)
RAU	Strand (Power Str)	RAV	Van der Stel(out of use)
RAW	Macassar	RAX	G.Bay - Borehole (G/bay)(out of use)BW
RAY	W/water - Melton Rose (Kleinvlei)	RAZ	Eastern High Level 2
RBC	Fountain Pump Concourse	RBD	Burg Road Subway - Stormwater
RBE	Beta Road	RBF	Steel Doors (Bantry Bay - Seacliff Rd)
RBG	Civic Cente F5	RBH	Hartleyvale
RBI	Rouwkoop Rd Subway - Stormwater	RBJ	Saunders Rock
RBM	Stock Road	RBN	Mowbray Workshop - Raapenberg
RBO	Ascot Street	RBP	Pinelands Sports Fields
RBR	Millers Point	RBS	Bridge Ways
RDZ	Harbour Island	REA	Bloemhof Office WDM&S
REA	Hendon Park	REA	Air Pollution
REB	Durbanville Office - WDM&S	REB	Fleur Park
REC	Head Office - Water City	RED	Kuilsriver Municipality Office - WDM&S
RED	Hillstar - E.A.M. Workshop	REE	Paul Sauer Building Office - WDM&S
REE	Bellville EAM - Sacks Circle	REF	Water Pollution Control (Athlone)- WDM&S
REG	Plumstead Office - WDM&S	REG	Hillstar (Central)
REH	Muller Street	REH	Plattekloof Workshop
REI	Blue Waters	REJ	Kendal Road
REK	Atlantis	REK	Pinelands
REL	Delft	REL	Raapenberg (EAM) Workshop
REM	Killarney (not in use)	REN	Khayelitsha Workshop

[redacted]

REN	Killarney EAM Depot	REO	Klipfontein
REO	Borcherds Quarry - EAM Workshop	REP	Langeberg
REP	Bellville - Workshop	REQ	Vaalfontein
REQ	Blomtuin E.A.M Depot	RER	Gordon's Bay Stormwater
RER	Cape Flats E.A.M Workshop	RES	Mitchell's Plain
RES	Mitchells Plain E.A.M Workshop	RET	Parow (A Wilhelm Rd)
RET	Specialised Technical Services - TOC	REU	Somerset West
REU	Simonstown E.A.M. Workshop	REV	Durbanville
REW	Goodwood (Socony Rd)	REX	Pinelands
REY	Socony Rd	REZ	Schaapkraal E.A.M. Depot
RFA	Brunswick Village - East	RFB	Brunswick Village - West
RFC	Colebrooke - North	RFD	Colebrooke - South
RFE	Royal Ascot	RFF	Big Bay Main
RFG	Killarney	RFH	Lokovaal
RFI	Fistante Kraal 3 - Pump Station	RFJ	Golfcourse (Macassar)
RFK	Scottsdene	RFL	Spyker Street
RFM	Napoleon Ave	RFN	Morkel Cottage
RFW	Goede Hoop	RFX	Coin Pump Station
RFY	Fistante Kraal 4 - Pump Station	RFZ	Airport Park 5
RGA	Monte Vista Pump Station	RGB	Romatex Pump Station
RGC	Queens Pump Station	RGD	Durbanville sports field P/S
RGE	Kraaifontein (Irrigation) (Water)	RGG	Sunny Side 2 Pump Station
RGH	Nedreg Pump Station	RGI	Klein Slangkop Point 14
RGL	Dassenberg	RGM	Koeberg Koppie
WCW	Raapenberg Bulk Pump Stations Depot	XAY	Bridgetown
XAZ	La Afrique	XBA	Knightbridge
XBB	Northgate Main	XBC	Railway
XBD	Wimbledon	XBE	Faure - Pump Station
XBG	Access Park (Access City)	XBH	Saxenberg
XBI	Winelands Pork	XBJ	Aquatic Club 1
XBK	Aquatic Club 2	XBL	Millenium Park
XBM	Black Mac (Sewer)	XBO	Northgate 2
XBP	Spes Bona Pump Station (Water)	XBQ	New Treated Effluent Station 1
XBR	New Treated Effluent Station 2	XBS	The Oval
XBT	Chapmans Peak No 2	XBU	Klipheuwel Pump Station
XBV	McDonalds/Goodwood Subway P/S	XBW	Northgate 3
XBX	Racing Park	XBY	Senate
XBZ	Airport Park 6	XCA	Symphony Way 1 Pump Station
XCB	Stonehurst	XCC	Langa Intersite - Stormwater
XCD	Langa Intersite (Sewerage)	XDA	New Du Noon
XDB	Annandale	XDC	Raapenberg Depot

[redacted]

XDG	Sagewood Pump Station	XDH	La Paloma
XDI	Burgundy Estate	XDJ	Kuyasa (Khayelitsha)
XDK	Prieska	XDL	Kelderhof
XDM	Zevendal (Booster) Pump Station	XDN	Symphony Way 2 TR5.1
XDO	Eerste River Sewer	XDP	Kanaal Straat
XDQ	Protea Heights	XDR	Silvermine
XDS	Victoria	XDT	Red Hill
XDU	Dido Valley Upper	XDV	Stables
XDW	Bumble Beach	XDX	Hardekraaltjie (Fleet)
XDY	The Watergate	XDZ	Jubilee
XEA	Parow Booster	XEB	Flamingo Vlei
XEC	Harmony	XED	Crammix
XEE	Steenbras High Site	XEF	Constantia Nek High Site
XEG	SignallHill High Site	XEH	Tygerberg High Site
XEJ	Langerberg High Site	XEK	NCC High Site
XEL	Sunningdale	XEM	Highbury
XEO	Kaapzicht Pump Station	XEP	Wood Drive
XEQ	Northpine(Shoprite)-Pump Station(Water)	XER	Atlantic Hills
XES	Spare (For Future Use)	XET	Parow Golf Course
XEU	Fish Hoek Subway - Stormwater	XEV	Stonewood
XSD	Small Doors		

4th level identifier (Site Type)

Identified by One Alpha character. It indicates the Main type of Facility on the Site. It is thus also possible that one Site/Location can have many different Facilities. This level is also maintained in the GIS system, with the lower levels (5-8) of non-linear assets only existing in SAP.

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

B	Abatoir, Market	O	Office/Building
C	Catchment Management	P	Pump Station
D	Dam	Q	Parks & Forest
F	Outfall	R	Reservoir
G	Cemetries	R	Water Works (CTA)

[redacted]

H	Pools	T	Treatment Plant
J	Ambulance Services	W	Workshop / Depot
K	Health Coordination	Z	Other
L	Pipeline, Sewer, Rising main.		
M	Mainlaying		

5th level identifier (Process Area)

Identified by Two Numeric characters. This defines the Process Area which will be found within a Process for a Plant or Facility

	Business Level	Branch Level	Site Level	Site Type Level	**Process Area Level**	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	**NN**	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

The 5th level indicator - Process areas codes have different sub categories and process areas for Water (e.g. a Water Treatment Works) vs Sanitation (e.g. a Wastewater Treatment works) facility types.

The first digit (1-9) is a grouping of high-level process areas, where:

- 1 – 5: Represents Core Processes
- 6 – 7: Represents Secondary Processes
- 8 - 9: Represents Auxiliary Processes

The grouping level (first character) of the 5th level identifier (Process Area) can be summarised as follow:

Process Level Grouping		Water	Sanitation
Core Process (1-5)	10	Primary Treatment	Inlet Works
	20	Sedimentation	Primary Sedimentation
	30	Filtration	Filtration
	40	Chlorination	Aeration / Activated Sludge
	50	Stabilization	Secondary Sedimentation
Secondary	60	Sludge Handling and Dewatering	Sludge handling and dewatering

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Process (6-7)	70	Pumping Systems	Effluent Treatment, Storage and Pumping Systems
Aux Process (8-9)	80	Grounds, Roads, Dams, Reservoirs, Tanks, Pipelines and Buildings	
	90	Power Generation and Utilities	

Within each of the groupings above, specific numbers have been allocated for specific process areas within the process level grouping as per table below:

Primary Processes:

	Water			Sanitation		
Core Processes	**10**	**Primary Treatment**		**10**	**Inlet Works**	
	11	Raw Water Intake		11	Inlet and Pumps	
	12	Lime Dosing System 1	(pH buffering.) excl. Atlantis (pre lime, NaOH)	12	Screens Line 1	
	13	Lime Dosing System 2		13	Screens Line 2	
	14	Softening	(Demineriliziing) ion exchange, membrane technologies	14	Grit removal Line 1	
	15	P.A.C. System No.1	(Taste, Smell)	15	Grit removal Line 2	
	16	P.A.C. System No.2	(Taste, Smell)	16	Equalisation Basin	
	17	Coagulant Dosing 1	(Flocculent) Incl. Alum, Sodium, Ferric, Polly electrolyte, Sodium Silicate	17	Waste removal	
	18	Coagulant Dosing 2		18		
	19	Dust Extraction		19		
	20	**Sedimentation**		**20**	**Primary Sedimentation**	**PST's**
	21	Settling Tanks Bank 1	Multiple Sedimentation Tanks grouped into a Bank/Line	21	Primary Sedimentation Tank 1	PST No. 1
	22	Settling Tanks Bank 2		22	Primary Sedimentation Tank 2	PST No. 2
	23	Settling Tanks Bank 3		23	Primary Sedimentation Tank 3	PST No. 3
	24	Settling Tanks Bank 4		24	Primary Sedimentation Tank 4	PST No. 4
	25	Conditioning Tanks Bank 1	Multiple Conditioning Chambers/Tanks grouped into a Bank/Line	25	Primary Sedimentation Tank 5	PST No. 5
	26	Conditioning Tanks Bank 2		26	Primary Sedimentation Tank 6	PST No. 6
	27	Conditioning Tanks Bank 3		27	Primary Sedimentation Tank 7	PST No. 7
	28	Conditioning Tanks Bank 4		28	Primary Sedimentation Tank 8	PST No. 8
	29			29	Primary Sedimentation Tank 9	PST No. 9
	30	**Filtration**		**30**	**Filtration**	
	31	Blowers	Blowers supplying Air for Scouring of Filters	31	Bio-Filtration	



	32	Filter Bank 1	Multiple Filters grouped into a Bank/Line	32	Ultra Filtration	Membrane Filters
	33	Filter Bank 2		33	Filter Bank	
	34	Filter Bank 3		34		
	35	Filter Bank 4		35		
	36			36		
	37			37		
	38			38		
	39			39		
	40	**Chlorination**		**40**	**Aeration / Activated Sludge**	
	41	Pre-Chlorination		41	Biological Reactor 1	Reactor No. 1
	42	Final Chlorination		42	Biological Reactor 2	Reactor No. 2
	43	Reservoir Chlorination		43	Biological Reactor 3	Reactor No. 3
	44			44	Biological Reactor 4	Reactor No. 4
	45			45	Biological Reactor 5	Reactor No. 5
	46			46	Biological Reactor 6	Reactor No. 6
	47			47	Biological Reactor 7	Reactor No. 7
	48			48	Biological Reactor 8	Reactor No. 8
	49	Chlorine Storage		49	Blowers	Blowers supplying Air for Aeration of Reactors
	50	**Stabilization**		**50**	**Secondary Sedimentation**	**SST's**
	51	Final Lime System 1		51	Clarifiers Line 1	Clarifiers for Line 1
	52	Final Lime System 2		52	Clarifiers Line 2	Clarifiers for Line 2
	53	CO2		53	Clarifiers Line 3	Clarifiers for Line 3
	54			54	Clarifiers Line 4	Clarifiers for Line 4
	55			55	Clarifiers Line 5	Clarifiers for Line 5
	56			56	Clarifiers Line 6	Clarifiers for Line 6
	57			57	Clarifiers Line 7	Clarifiers for Line 7
	58	Stabilization Chambers		58	Clarifiers Line 8	Clarifiers for Line 8
	59	Lime Silo`s	Bulk lime storage silos	59	Clarifiers Line 9	Clarifiers for Line 9

Secondary Processes:

Secondary Processes	**60**	**Sludge Handling and Dewatering**		**60**	**Sludge handling and dewatering**	
	61	Sludge Pumping		61	Gravity Thickener	
	62	Poly Dosing		62	Dissolved Air Flotation	
	63			63	Thickening/dewatering Equipment	
	64	Centrifuges		64	Digesters	
	65			65	Supernatant pumping	
	66			66	Polyelectrolyte Dosing	

[redacted]

	67	Sludge Removal		67	Thermal Drying	
	68			68	Holding Tanks	
	69			69		
	70	**Pumping Systems**		**70**	**Effluent Treatment, Storage and Pumping Systems**	
	71	Sludge Water Recovery	Pumping of Sludge Water Recovery	71	Holding Tanks	
	72	Backwash Water	Pumping of Backwash Water	72	Disinfection	
	73	Backwash Water Recovery	Pumping for Backwash Water Recovery	73	Re-use Onsite	Pumping of Onsite Effluent Distribution
	74	Potable Water Onsite	Pumping of Potable Water for Onsite Usage	74	Chemical Dosing	Pumping of Chemical Dosing
	75	Potable Water Reticulation Network	Pumping of Potable Water in the Distribution/Reticulation Network	75	Wastewater Reticulation Network	Pumping of Wastewater in the Distribution/Reticulation Network
	76	Raw Water Pumping	Pumping of Raw Water	76	Treated Effluent Network	Pumping of Treated Effluent in the Distribution/Reticulation Network
	77	Reservoir Supply Pumping	Pumping of Potable Water to a Reservoir	77	Sludge	Pumping of Onsite Sludge, e.g. RAS, WAS
	78	Bore Holes	Pumping Water from Bore Holes	78		
	79			79	Storm Water	Pumping of Storm Water

Auxiliary Processes:

Auxiliary Processes	**80**	**Grounds, Roads, Dams, Reservoirs, Tanks, Pipelines and Buildings**		**80**	**Grounds, Roads, Pond s, Reservoirs, Tank, Pipelines and Buildings.**	
	81	Grounds & Roads		81	Grounds & Roads	
	82			82		
	83	Dams & Ponds		83	Dams & Ponds	
	84	Reservoirs		84	Reservoirs	
	85	Tanks		85	Tanks	
	86	Pipelines & Channels		86	Pipelines & Channels	
	87	Buildings	Buildings	87	Buildings	
	88	Sub-Structures	Structures	88	Sub-Structures	
	89			89		
	90	**Power Generation and Utilities**		**90**	**Power Generation and Utilities**	
	91	Transport / Small plant	Equipment	91	Transport / Small plant	Equipment
	92	Low Voltage	Power Generation & Distribution, Supply	92	Low Voltage	Power Generation & Distribution, Supply
	93	Compressed Air		93	Compressed Air	
	94	SCADA, PLC and Data Management		94	SCADA, PLC and Data Management	
	95	Laboratory Equipment	Equipment	95	Laboratory Equipment	Equipment

[redacted]

	96	Communication Equipment	Radio, Telemetry and Telephone Equipment	96	Communication Equipment	Radio, Telemetry and Telephone Equipment
	97	Medium Voltage		97	Medium Voltage	
	98	Site Specific Utilities	Eg. Bio-Filter for Treatment of Onsite Sewer	98	Site Specific Utilities	Eg. Irrigation Water Pumping
	99	Safety Equipment	Fire fight, lifting equip, showers/basins, Housekeeping, Safety rep. inspections	99	Safety Equipment	Fire fight, lifting equip, showers/basins, Housekeeping, Safety rep. inspections

6th level identifier (Complex Asset Level)

Identified by Two Alpha characters, followed by Two Numeric characters. Some assets are seen as Complex Assets as it forms a "Unit" via the combination of various assets. Some minor assets are also grouped into logical groups at this level.

A Grouping of Physical Assets which together form a Complex Asset. (Examples: Aerator Unit/System; Building, Pumpline set etc)

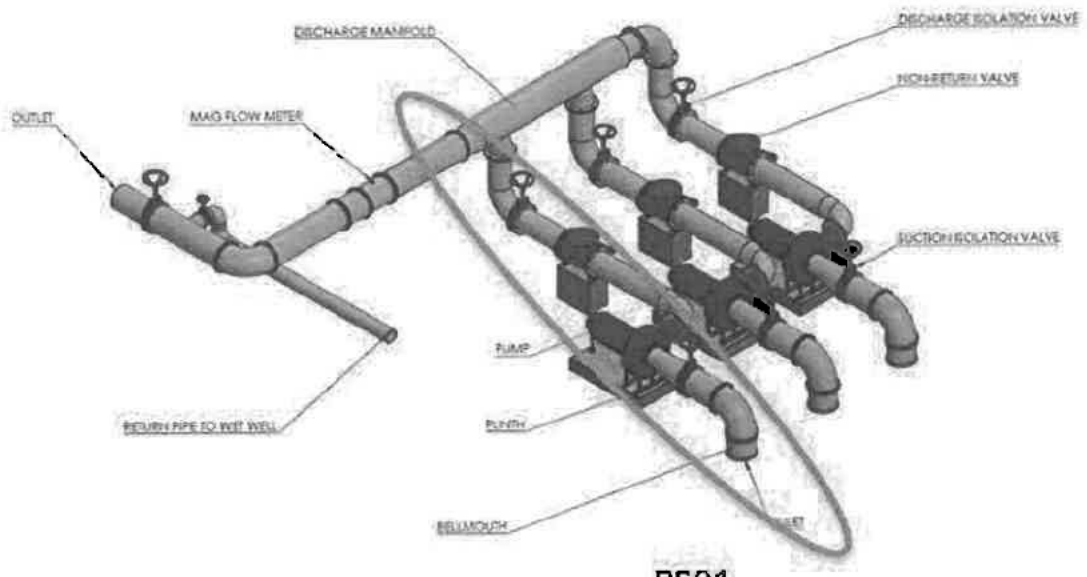
A Complex Asset can be procured as a Capital item, but normally not replaced in totality.

A Group of Assets is a Logical Grouping of Physical Assets to provide better hierarchical structuring. (Examples: Fire Fighting Equipment; Lights, Etc.). The financial unit of account for new assets recorded in the SAP financial module is set at Level 6 for non-linear assets.

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	**Complex Asset Level**	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	**AANN**	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

Below is an example of a complex asset – pump line set

[redacted]



PS01

L6 Code	L6 Description	Main trade	Water Asset Class	Sewer Asset Class
AD	Diffused Aeration System	Mechanical	16920	13700
AE	Surface Aerator	Mechanical	16920	13700
AG	Agitator	Mechanical	16920	13700
AL	Air-Lift Pump	Mechanical	16920	13700
AR	Air Scour System	Mechanical	16920	13700
BC	Bio-Filter (Rotating Contactor)	Mechanical	16920	13700
BD	Building	Civil / Facilities	16800	13800
BF	Bio-Filter (Trickling)	Mechanical	16920	13700
BL	Blower Unit	Mechanical	16920	13700
BO	Bio-Filter (Ponds)	Mechanical	16920	13700
BP	Belt Filter Press	Mechanical	16920	13700
BR	Boiler	Mechanical	16920	13700
CB	Conditioning Basin	Civil / Facilities	16800	13800
CF	Clarifier	Civil / Facilities	16800	13800
CL	Chlorination Equipment	Other	16930	13900
CM	Compactor	Mechanical	16920	13700
CO	CO2 equipment	Other	16930	13900
CT	Cooling Tower	Mechanical	16920	13700
CV	Conveyor Unit	Mechanical	16920	13700
CX	Control Equipment	Specialised Services	16930	13900

[redacted]

DA	Dissolved Air Flotation	Mechanical	16920	13700
DC	Direct Current Distribution Board	Electrical	16910	13600
DG	Digester Unit	Mechanical	16920	13700
DM	Pond	Civil / Facilities	16800	13800
DS	Dosing System	Mechanical	16920	13700
DU	Dust Unit	Mechanical	16920	13700
EB	Equalisation Basin	Civil / Facilities	16800	13800
ED	Electrical Distribution Boards	Electrical	16910	13600
EI	Electrical Control Cabinet - Indoor	Electrical	16910	13600
EK	Electrical Kiosk	Electrical	16910	13600
EO	Electrical Control Cabinet - Outdoor	Electrical	16910	13600
FC	Dynamic Power Factor Correction System	Electrical	16910	13600
FE	Feeder	Mechanical	16920	13700
FF	Fire Fighting Equipment	Other	16920	13700
FS	Flitration System	Mechanical	16920	13700
GC	Grit Classifier Unit	Mechanical	16920	13700
GD	Ground	Civil / Facilities	16800	13800
GS	Gravity Thickener	Mechanical	16920	13700
HP	Hopper	Civil / Facilities	16800	13800
LE	Lifting Equipment	Mechanical	16920	13700
LS	Gravity Belt Thickener	Mechanical	16920	13700
MA	Macerator (Comminutor)	Mechanical	16920	13700
MD	Pipe Manifold, delivery	Mechanical	16920	13700
MS	Pipe Manifold, suction	Mechanical	16920	13700
MX	Mixer	Mechanical	16920	13700
OD	Odour Control Unit	Other	16930	13900
PA	Sludge Pasteurization Equipment	Mechanical	16920	13700
PG	Power Generator Set (GENSET)	Fleet	16910	13600
PO	Pond System	Civil / Facilities	16800	13800
PS	Pump Line Set	Mechanical	16920	13700
PT	Turbine Set	Mechanical	16920	13700
PU	Programmable Logic Controller Unit	Specialised Services	16930	13900
PX	Archimedean Screw Pump Set	Mechanical	16920	13700
RS	Reservoir	Civil / Facilities	16800	13800
RT	Radio (/Telephone) System	Other	16930	13900
RX	Bioreactor	Civil / Facilities	16800	13800
SA	Silo	Civil / Facilities	16800	13800

[redacted]

SC	Screening Unit	Mechanical	16920	13700
SD	Skip Dolly System	Mechanical	16920	13700
SE	SCADA Equipment	Specialised Services	16930	13900
SP	Screening Press Unit	Mechanical	16920	13700
ST	Sedimentation Tank	Civil / Facilities	16800	13800
SU	Sump	Civil / Facilities	16800	13800
SV	Surge Vessel Equipment	Mechanical	16920	13700
TK	Tank	Mechanical	16920	13700
TS	Telephone System	Other	16930	13900
TU	Telemetry Unit	Specialised Services	16930	13900
UV	Ultraviolet (UV) Dosing System	Electrical	16910	13600
VC	Medium Voltage Backup & Control Equipment	Electrical	16910	13600
VD	Variable Frequency Drive Equipment	Electrical	16910	13600
VF	Medium Voltage Power Factor Correction	Electrical	16910	13600
VM	Miniature Substations (Minisub)	Electrical	16910	13600
VO	Medium Voltage Overhead Line	Electrical	16910	13600
VP	Medium Voltage Panel	Electrical	16910	13600
VR	Ring Main Unit	Electrical	16910	13600
VS	Medium Voltage Starter Panel	Electrical	16910	13600
VX	Transformer Equipment	Electrical	16910	13600
WB	Wash Booth	Mechanical	16920	13700
WW	Wet Well	Civil / Facilities	16800	13800
CH	Channel	Civil / Facilities	16800	13800
AU	**Auxiliary**			
SM	**Transport & Small Plant**			
DW	**Dry Well**			

7th level identifier (Asset Level)

Identified by Three Alpha characters, followed by Two Numeric characters. It identifies the unique asset. An asset either forms part of a Complex Asset or it is just grouped into an Asset Grouping. An Asset is normally of Capital nature (i.e. it is not a spare component). An Asset has independent physical or functional identity and specific attributes, such as different life expectancy, maintenance and renewal requirements and regimes, risk or criticality.

[redacted]

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	Instrument Level
Code	A	A	AAA	A	NN	AANN	AANN	XXXNN
Level	1	2	3	4	5	6	7	8

Level 7	Description
ACT	Actuator
BSC	Bar Screen
PIP	Pipe Work
PLA	Platform
HOP	Hopper Structure
SCA	Weight Scale
SLB	Slurry Bowl
STI	Stirrer
DCT	Ducting
FAN	Fan
FIL	Filter
BAF	Baffle
GRA	Grating
KIP	Kick Plates
LAD	Ladder
RAA	Rake Arm
RST	Rotating Structure
SCB	Scum Box
SCO	Scum Outlet
SCS	Scum Skimmer
SLP	Slip Ring
SPR	Scraper
TNB	Tank Bridge
TRH	Trough
WEI	Weir
WHA	Wheel Assembly
BPL	Base Plate Assembly
CUP	Coupling
AIK	Air Knife
DIF	Air Diffuser
MEM	Membrane
CLR	Chlorinator
LIQ	Liquid Trap

[redacted]

LOC	Load Cell
PVE	Pressure Vessel
REG	Regulator
INJ	Injector
SLO	Silo Structure
PIT	Pipe Support
STN	Strainer
UFM	UNIBOX: Fabricated frame electric motors
ALS	Automatic Lubrication System
CEN	Decanter Centrifuge
PON	Pond
SUV	Surge Vessel
FEN	Fencing
GAT	Gate
GRD	Ground / area
RDS	Road
DAP	Domestic Appliance
DEH	De-humidifier
DOO	Doors
FLO	Floor
GDP	Gutters & Downpipes
LFA	Louvre Filter Assembly
LGT	Light
LIF	Lift
MIR	Mirrors
ROO	Roof
TAP	Taps
TBW	Toilet Bowls & Cisterns
URI	Urinals
WBS	Wash Basins
WIN	Windows
DFS	Duck Foot Seating
GUR	Guide Rail
VEN	Ventilation System
BUC	Bus Coupler
DOS	Direct Online Starters
MET	Metering - electrical
PFC	Power Factor Correction
PLC	Programmable Logic Controllers
PNL	Panel Structure
STS	Star Delta Starters
SWT	Switches / Switch Over

[redacted]

TEL	Telemetry Equipment
VFC	Variable Frequency Controllers
VVC	Variable Voltage Controllers
CAP	Capacitor Banks
CAS	Capacitor Switching Controllers
CEE	Container / Enclosure
FSS	Fire Suppression System
PSS	Pepper Spray System
XST	Exhaust
DRY	Air Dryer
HRD	Hardware
SOF	Software
TPN	Telephone Equipment
SER	Servers
COV	Converters
CPU	Central Processing Units
ICA	Input Cards
NSW	Network Switches (Ethernet)
OUC	Output Cards
PSU	Power Supply Units
RDU	Running (LED) Display Units
REP	Repeaters
FIR	Firewall/Router
MON	Monitors
PAT	Patch Panels
RAM	Radio Mast
ANT	Antenna
MOD	Modem
PDU	Programmable (LED) Display Unit
DCB	Direct Current Distribution Board
RTU	Remote Terminal Unit
VFD	Variable Frequency Drive
MSH	MiniSub Housing
RMU	Ring Main Unit
CRA	Cross-Arm
FCA	Fuse Carrier Assembly
POL	Pole
EMR	Energy Meter
PAN	Power Analyser
PRR	Protection Relay
MCN	MV Contactor
NEC	Neutral Earth Compensator

[redacted]

NER	Neutral Earth Resistor/Neutral Ground Resistor
DIS	Disk
ENC	Enclosure
SHF	Shaft
BRG	Bearing
FMB	Filter Media Bed
FFE	Fire Extinguisher
FHD	Hydrant
HOR	Fire Hose Reel
CBK	Chain block
HOK	Hook
SHA	Shackle
SLG	Sling
SPB	Spreader Bar
SBR	Spray Bar
SCN	Screen
PAD	Paddle
HYD	Hydraulic Unit
PRS	Hydraulic Press
SDS	Skip Dolly Systems
AER	Aerator Impellor
PRO	Propeller
SUM	Sump Structure
TWR	Tower Structure
BPS	Belt Filter Press Structure
FIB	Filter Belt
ROL	Rollers
TRS	Tracking System
GBT	Gravity Belt Thickener Structure
FUE	Fuel System
CTP	Condensate Trap
FLT	Flame trap
UVB	UV Bank Hydraulic Lamp Cleaning System
UVC	UV Bank Control Centre
UVH	UV Bank (grouping of lamps)
BLO	Blower
VLV	Valve
GBX	Gearbox
MOT	Motor
AIR	Air Receiver
COM	Air Compressor

[redacted]

TNK	Tank Structure
AIC	Air Conditioning Unit
BLG	Building Structure
PMP	Pump
HAR	Hand Rails
STT	Structure
CHL	Channel Structure
CHM	Chamber Structure
CON	Conveyor
RAD	Radio
CRN	Crane
HEX	Heat Exchanger
DBD	Distribution Board
BUB	Busbar
CBR	Circuit Breakers
UPS	Uninterruptible Power Supply
COT	Controller
MAC	Macerator (Comminutor)
PIS	Pipe Support
CTF	Current Transformer
VOT	Voltage Transformer
ALT	Alternator
BAT	Battery Bank
CSM	Cooling System
ENG	Engine
BTU	Battery Charging / Tripping Unit
LVC	Low Voltage Components
TRF	Transformer
COD	Conductor
INS	Insulator
MCB	MV Circuit Breaker
SMP	**Small Plant**

8th level identifier (Instrument Level)

Identified by Three characters, followed by Two Numeric characters. It identifies the unique instrument. Instruments are always related to a specific Asset at Level 7. Instruments Include Depth Gauges, Flow Meters, Level Gauges, Level Monitoring, Ph Analysers, Sensors, Transmitters, Etc.

	Business Level	Branch Level	Site Level	Site Type Level	Process Area Level	Complex Asset Level	Asset Level	**Instrument Level**

[redacted]

Code	A	A	AAA	A	NN	AANN	AAANN	XXXNN
Level	1	2	3	4	5	6	7	8

Instruments will be coded as per the ISA standard for the first 3 characters (Instrument Type Code column below) with 2 numbers to indicate position in case of multiple instruments of the same type.

Instrument Type Code	First Letter (Measurable)	Succeeding letter(1)	Succeeding letter(2)	Common use
AIT	Analysis	Indicator	Transmitter	Other Analyzers not listed
CIT	Conductivity	Indicator	Transmitter	Conductivity
DIT	Dissolved Oxygen	Indicator	Transmitter	Dissolve Oxygen/pH/Turbidity
FIT	Flow	Indicator	Transmitter	Magflow/Ultrasonic
FS_	Flow	Switch		Thermal switch, paddle switch
GIT	Turbidity	Indicator	Transmitter	Turbidity/Suspended Solids
LIT	Level	Indicator	Transmitter	Radar/Ultrasonic/Pressure
OIT	pH	Indicator	Transmitter	pH
PG_	Pressure	Glass/Viewing device		Pressure gauge
PIR	Pressure	Indicate & Record		Pressure Impulse Recorder
PIT	Pressure	Indicator	Transmitter	Pressure
PP_	Pressure	Point		Test point on a pressure line
PT_	Pressure	Transmitter		Pressure transmitter without display
PS_	Pressure	Switch		Mechanical switch, Electronic switch
TT_	Temperature	Transmitter		PT100
VT_	Vibration	Transmitter		Vibration sensors
ZS_	Position	Switch		Proximity switch, float switch, tuning/vibration forks
ZSH	Position	Switch	High	Proximity switch, float switch, tuning/vibration forks
ZSL	Position	Switch	Low	Proximity switch, float switch, tuning/vibration forks

All instruments will have the following unique attribute data (as a class/characteristic in SAP PM) with allowable values and dropdown lists built into the "Equipment and maintenance template" to ensure master data governance:

INSTRUMENT TYPE

[redacted]

RANGE
MEASUREMENT
INSTRUMENT METHOD
OUTPUT TYPE (ANOLOG / DIGITAL)
I / O LINK
MATERIAL MEASURED
MANUFACTURER
MODEL NUMBER
SUPPLY VOLTAGE
SIGNAL TYPE
UNIT OF MEASUREMENT
RANGE MIN
RANGE MAX

In a similar fashion, all level 7 and level 8 assets will have the following generic attribute data that will also be populated via the "Equipment and maintenance template"

Functional Location
Description of functional location
Type of Technical Object
Position in superior technical object
Reference functional location
Superior functional location
Sort Field
Weight
Weight Unit
Size/dimension
Start-up Date of the Technical Object
Acquisition Value
Currency Key
Acquisition date
Manufacturer of Asset
Country of manufacture
Manufacturer model number
Year of construction
Month of construction
Manufacturer part number
Manufacturer serial number

[redacted]

Similar to instruments, Level 7 assets could also have unique attribute data, see below example for unique attribute data for asset type = Valves

Class Number	Class Description	Characteristic Name	Description for the Characteristic	Value List
ZWS-VLV	Valve	ZWS-VALVE_TYPE	Valve Type	VALVETYPE
ZWS-VLV	Valve	ZWS-VALVE_FUNCTION	Valve Function	VALVEFUNCTION
ZWS-VLV	Valve	ZWS-BACKFLOW_VALVE_TYPE	Backflow Valve Type	VALVENONRETURNTYPE
ZWS-VLV	Valve	ZWS-NOMINAL_DIAMETER	Nominal Diameter	NOMDIAMETER
ZWS-VLV	Valve	ZWS-PRESSURE_RATING	Pressure Rating	
ZWS-VLV	Valve	ZWS-PROTECTION_TYPE	Protection Type	PROTECTIONTYPE
ZWS-VLV	Valve	ZWS-VALVE_ACTUATION	Actuation	VALVEACTUATION
ZWS-VLV	Valve	ZWS-ACCESSIBILITY	Accessibility	ACCESSTYPE
ZWS-VLV	Valve	ZWS-TAG_NUMBER	Tag Number	
ZWS-VLV	Valve	ZWS-ALT_TAG_NUMBER	Alt Tag Number	
ZWS-VLV	Valve	ZWS-CONSTRUCTED_MATERIAL	Constructed Material	CONSTRUCTEDMATERIAL

The last column in the table above "Value List", refers to dropdown selections configured in the "Equipment and maintenance template", for example for the Characteristic "Valve Type" the following are allowed values:

Value List	Characteristic Value
VALVETYPE	ACTUATED VALVE
VALVETYPE	AIR RELEASE
VALVETYPE	BACKFLOW PREVENTION
VALVETYPE	BALL
VALVETYPE	BUTTERFLY
VALVETYPE	CHOKE
VALVETYPE	DIAPHRAGM
VALVETYPE	GATE
VALVETYPE	GLOBE
VALVETYPE	KNIFE GATE
VALVETYPE	NEEDLE
VALVETYPE	NON RETURN
VALVETYPE	PINCH
VALVETYPE	PISTON
VALVETYPE	PLUG
VALVETYPE	SELF REGULATED
VALVETYPE	SLEEVE
VALVETYPE	SLUICE
VALVETYPE	STOP BOARDS

The latest class / characteristic data and request for changes can made through the relevant CMMS manager.

[redacted]

Requirements regarding use of the "Equipment and maintenance template"

Implementation of the above described master data standards will be done via the latest "Equipment and maintenance template" for any new infrastructure by the time that the practical completion certificate has been issued. All data will then be transferred to SAP before the end of the defects & liability period.

- The latest "Equipment and maintenance template" must be completed in full including all attributes applicable to each asset.
- All OEM preventative maintenance schedules to be converted into the standard CoCT template format.
- To guide completion of the template the latest "Plant numbering system" document must also be requested from the Project Manager (who will obtain from the CMMS Manager) and reviewed to ensure that all process areas, complex assets, assets and instruments on each site is recorded in accordance with W&S master data standards.
- Training material and a completed sample for reference use can be provided upon request.
- Before starting the template, the SAP Code (Level 4 functional location code) for the facility must be requested from the CoCT CMMS Manager via the Project manager.
- Once correctly completed the template will assign the level 5-8 coding for each asset, which determines the CoCT Tag numbers to be used on all relevant drawings, diagrams, interfaces and labelling as part of the project as per sample below:

Level		**SAP FLOC Code** (example)	: **Description** (example)
Level 1	Business	W	: Water & Sanitation
Level 2	Branch	WW	: Bulk Water
Level 3	Site	WWPVV	: Voëlvlei
Level 4	Site Type	WWPVVT	: Treatment Plant
Level 5	Process Area	WWPVVT-77	: Reservoir Supply Pumping
Level 6	Complex Asset	WWPVVT-77PS01	: Pump Line System 1
Level 7	Asset	WWPVVT-**77PS01-PMP01**	: Pump 1, Pump Line 1
Level 8	Instrument (opt)	WWPVVT-**77PS01-PMP01-VT_01**	: Vibration Transmitter Pump1, Line1

For the above example the following **tag numbers** are applicable:

77PS01-PMP01 = Tag number for Pump 1

77PS01-PMP01-VT_01 = Tag number for the Vibration Transmitter instrument monitoring Pump 1

Photos

[redacted]

Individual photos of all Level 6 complex assets, Level 7 assets and Level 8 instruments are required in JPG format no larger than 1MB per photo.

Each photo should should be taken from an angle to show the entire asset (not a closeup of the nameplate only)

Naming convention of the photo must follow the full functional location code. E.g. for example above, there must be three individual photos complex named:

"WWPVVT-77PS01.jpg" – showing the entire pump line system (which would typically consist of valves, pipework, pump and motor

"WWPVVT-77PS01-PMP01" - showing only Pump 1

"WWPVVT-77PS01-PMP01-VT_01.jpg" – showing only the vibration transmitter on Pump 1

Linked documents

Relevant material referred to in this document can be found here:

[redacted]

Asset Management

The following high-level Asset Management attributes for criticality, condition and life cycle status have been setup on the PM system:

Class Description	Characteristic Name	Description for the Characteristic	Value List
Criticality	ZWS-COST_MAINTENANCE_IMPACT	Cost & Maintenance Impact	COSTMAINT
Criticality	ZWS-DOWNTIME_SERVICE_IMPACT	Downtime & Service Delivery Impact	DOWNSERVICE
Criticality	ZWS-HEALTH_SAFETY_IMPACT	Health & Safety Impact	HEALTHSAFETY
Criticality	ZWS-ENVIROMENTAL_IMPACT	Environmental Impact	ENVIRON
Criticality	ZWS-	Legal Compliance Impact	LEGALCOMP

[redacted]

	LEGAL_COMPLIANCE_IMPACT		
Criticality	ZWS-REPUTATION_IMPACT	Reputation Impact	REPUTATION
Criticality	ZWS-OVERALL_CONSEQUENCE	Overall Consequence Rating	
Criticality	ZWS-PROBABILITY_FAILURE	Probability of Failure	PROBABILITY
Criticality	ZWS-ASSET_CRITICALITY	Asset Criticality	
Criticality	ZWS-BRE	Business Risk Exposure	
Condition	ZWS-CONDITION_GRADE	Asset Condition Grade	CONDITION
Life Cycle Status	ZWS-CONDITION_GRADE	Asset Condition Grade	CONDITION
Life Cycle Status	ZWS-PERFORMANCE_GRADE	Performance Grade	PERFORMANCE
Life Cycle Status	ZWS-COST_OPERATION_GRADE	Cost of Operation Grade	OPERATION
Life Cycle Status	ZWS-UTILIZATION_GRADE	Utilization Grade	UTILIZATION

The following value lists are configured for the above attributes:

Value List	Characteristic Value	Characteristic Value description
COSTMAINT	1	Minor
COSTMAINT	2	Moderate
COSTMAINT	3	Serious
COSTMAINT	4	Critical
COSTMAINT	5	Catastrophic
DOWNSERVICE	1	Minor
DOWNSERVICE	2	Moderate
DOWNSERVICE	3	Serious
DOWNSERVICE	4	Critical
DOWNSERVICE	5	Catastrophic
HEALTHSAFETY	1	Minor
HEALTHSAFETY	2	Moderate
HEALTHSAFETY	3	Serious
HEALTHSAFETY	4	Critical
HEALTHSAFETY	5	Catastrophic
ENVIRON	1	Insignificant
ENVIRON	2	Minor
ENVIRON	3	Moderate
ENVIRON	4	Critical
ENVIRON	5	Catastrophic
LEGALCOMP	1	Minor
LEGALCOMP	2	Moderate
LEGALCOMP	3	Serious

[redacted]

LEGALCOMP	4	Critical
LEGALCOMP	5	Catastrophic
REPUTATION	1	Minor
REPUTATION	2	Moderate
REPUTATION	3	Serious
REPUTATION	4	Critical
REPUTATION	5	Catastrophic
PROBABILITY	1	Rare
PROBABILITY	2	Unlikely
PROBABILITY	3	Moderate
PROBABILITY	4	Likely
PROBABILITY	5	Almost Certain
CONDITION	1	Very Good
CONDITION	2	Good
CONDITION	3	Fair
CONDITION	4	Poor
CONDITION	5	Very Poor
PERFORMANCE	1	Substantially Exceeds Requirements
PERFORMANCE	2	Exceeds Requirements Moderately
PERFORMANCE	3	Meets Requirements
PERFORMANCE	4	Moderate Non-Compliance
PERFORMANCE	5	Substantial Non-Compliance
OPERATION	1	Substantially Below Norm
OPERATION	2	Moderately Below Norm
OPERATION	3	Within Norm
OPERATION	4	Moderately Exceeds Norm
OPERATION	5	Substantially Exceeds Norm
UTILIZATION	1	Not Used
UTILIZATION	2	Underused
UTILIZATION	3	Normal Use
UTILIZATION	4	At Capacity
UTILIZATION	5	Overloaded

In addition, detailed pump station survey attributes have been developed under the following categories:

GENERAL SECTION
SUMP
INLET PIPE
RISING MAIN
PUMPS AND MOTORS

[redacted]

HYDRAULICS
ASSETS
SENSORS
OPERATIONAL
STRUCTURE / FACILITIES
CONDITION ASSESSMENT
AUDIT SUMMARY

Asset useful life reporting at the complex asset level and above is to be run from the SAP FI-AA module were the following asset classes and expected useful lives are assigned for Water and Sewer infrastructure respectively:

Asset Class Water			**EUL**
16100	InfraWtr:Meters	Infrastructure Water: Meters	15
16200	InfraWtr:Mains	Infrastructure Water: Mains	45
16300	InfraWtr:Rights	Infrastructure Water: Rights	20
16400	InfraWtr:Reticulatio	Infrastructure Water: Reticulation	45
16500	InfraWtr:Res/Tanks	Infrastructure Water: Reservoirs/Tanks	50
16600	InfraWtr:PumpStatio n	Infrastructure Water: Pump Stations	20
16700	InfraWtr:Networks	Infrastructure Water: Networks	45
16800	InfraWater Civil	Infrastructure Water Civil Structure	50
16900	InfrWtr:Desalination	Infrastructure Water: Desalination	30
16910	InfrWtr:Mechanical	INFRASTRUCTURE WATER: ELECTRICAL EQUIPMENT	20
16920	InfrWtr:Electrical	INFRASTRUCTURE WATER: MECHANICAL EQUIPMENT	25
16930	InfrWtr:PCS	INFRASTRUCTURE WATER: PROCESS CONTROL EQUIPMENT	20

Asset Class Sewer			**EUL**
13100	InfraSw:Sewers	Infrastructure Sewer: Sewers	45
13200	InfraSw:OutfallSewer	Infrastructure Sewer: Outfall Sewers	50
13300	InfraSw:PurificWorks	Infrastructure Sewer: Purification Works	20
13400	InfraSw:SewerPumps	Infrastructure Sewer: Sewer Pumps	15
13500	InfraSw:SludgeMach.	Infrastructure Sewer: Sludge Machines	15
13600	InfraSw:Electrical	INFRASTRUCTURE SEWER: ELECTRICAL EQUIPMENT	20
13700	InfraSw:Mechanical	INFRASTRUCTURE SEWER: MECHANICAL EQUIPMENT	25
13800	InfraSw: Civil	INFRASTRUCTURE SEWER: CIVIL STRUCTURE	50
13910	InfraSw:PS	INFRASTRUCTURE SEWER: PUMP STATION	20
13900	InfraSw: PCS	INFRASTRUCTURE SEWER: PROCESS CONTROL EQUIPMENT	20

[redacted]

At lower levels (L7 and L8) asset EUL is to be managed and reported from the SAP PM module as integration with finance is done only down to level 6 (complex asset). Level 6 and above is the appropriate level for draft capital planning to take place with asset owners responsible for planning for replacement of complex assets as well as new infrastructure / capacity requirements.

The "Start-up Date of the Technical Object" field is to be used to determine the age of the asset and compared to the following guideline expected useful lives (EUL) to report on assets that might require replacement. Criticality, maintenance history and lifecycle assessment data can be utilised to prioritise replacement decisions.

Level 7	Description	EUL
ACT	Actuator	25
BSC	Bar Screen	20
PIP	Pipe Work	45
PLA	Platform	30
HOP	Hopper Structure	60
SCA	Weight Scale	15
SLB	Slurry Bowl	15
STI	Stirrer	15
DCT	Ducting	15
FAN	Fan	15
FIL	Filter	10
BAF	Baffle	15
GRA	Grating	25
KIP	Kick Plates	25
LAD	Ladder	25
RAA	Rake Arm	25
RST	Rotating Structure	25
SCB	Scum Box	25
SCO	Scum Outlet	25
SCS	Scum Skimmer	25
SLP	Slip Ring	15
SPR	Scraper	15
TNB	Tank Bridge	30
TRH	Trough	45
WEI	Weir	45
WHA	Wheel Assembly	25
BPL	Base Plate Assembly	25
CUP	Coupling	25
AIK	Air Knife	25
DIF	Air Diffuser	25
MEM	Membrane	25
CLR	Chlorinator	15

[redacted]

LIQ	Liquid Trap	25
LOC	Load Cell	15
PVE	Pressure Vessel	50
REG	Regulator	15
INJ	Injector	15
SLO	Silo Structure	50
PIT	Pipe Support	50
STN	Strainer	20
UFM	UNIBOX: Fabricated frame electric motors	20
ALS	Automatic Lubrication System	25
CEN	Decanter Centrifuge	25
PON	Pond	50
SUV	Surge Vessel	50
FEN	Fencing	10
GAT	Gate	10
GRD	Ground / area	50
RDS	Road	30
DAP	Domestic Appliance	7
DEH	De-humidifier	10
DOO	Doors	40
FLO	Floor	50
GDP	Gutters & Downpipes	40
LFA	Louvre Filter Assembly	30
LGT	Light	25
LIF	Lift	25
MIR	Mirrors	15
ROO	Roof	50
TAP	Taps	20
TBW	Toilet Bowls & Cisterns	20
URI	Urinals	20
WBS	Wash Basins	20
WIN	Windows	20
DFS	Duck Foot Seating	20
GUR	Guide Rail	30
VEN	Ventilation System	15
BUC	Bus Coupler	50
DOS	Direct Online Starters	20
MET	Metering - electrical	15
PFC	Power Factor Correction	45
PLC	Programmable Logic Controllers	20
PNL	Panel Structure	45
STS	Star Delta Starters	20
SWT	Switches / Switch Over	20
TEL	Telemetry Equipment	20

[redacted]

VFC	Variable Frequency Controllers	20
VVC	Variable Voltage Controllers	20
CAP	Capacitor Banks	20
CAS	Capacitor Switching Controllers	20
CEE	Container / Enclosure	45
FSS	Fire Suppression System	20
PSS	Pepper Spray System	10
XST	Exhaust	20
DRY	Air Dryer	25
HRD	Hardware	10
SOF	Software	10
TPN	Telephone Equipment	20
SER	Servers	10
COV	Converters	10
CPU	Central Processing Units	10
ICA	Input Cards	10
NSW	Network Switches (Ethernet)	10
OUC	Output Cards	10
PSU	Power Supply Units	5
RDU	Running (LED) Display Units	10
REP	Repeaters	15
FIR	Firewall/Router	10
MON	Monitors	10
PAT	Patch Panels	10
RAM	Radio Mast	30
ANT	Antenna	20
MOD	Modem	10
PDU	Programmable (LED) Display Unit	10
DCB	Direct Current Distribution Board	15
RTU	Remote Terminal Unit	10
VFD	Variable Frequency Drive	20
MSH	MiniSub Housing	30
RMU	Ring Main Unit	45
CRA	Cross-Arm	25
FCA	Fuse Carrier Assembly	20
POL	Pole	20
EMR	Energy Meter	15
PAN	Power Analyser	15
PRR	Protection Relay	20
MCN	MV Contactor	20
NEC	Neutral Earth Compensator	20
NER	Neutral Earth Resistor/Neutral Ground Resistor	20
DIS	Disk	30

[redacted]

ENC	Enclosure	25
SHF	Shaft	25
BRG	Bearing	25
FMB	Filter Media Bed	25
FFE	Fire Extinguisher	20
FHD	Hydrant	20
HOR	Fire Hose Reel	20
CBK	Chain block	25
HOK	Hook	25
SHA	Shackle	10
SLG	Sling	10
SPB	Spreader Bar	10
SBR	Spray Bar	25
SCN	Screen	20
PAD	Paddle	25
HYD	Hydraulic Unit	35
PRS	Hydraulic Press	35
SDS	Skip Dolly Systems	25
AER	Aerator Impellor	25
PRO	Propeller	20
SUM	Sump Structure	50
TWR	Tower Structure	40
BPS	Belt Filter Press Structure	25
FIB	Filter Belt	1
ROL	Rollers	5
TRS	Tracking System	25
GBT	Gravity Belt Thickener Structure	25
FUE	Fuel System	25
CTP	Condensate Trap	30
FLT	Flame trap	30
UVB	UV Bank Hydraulic Lamp Cleaning System	10
UVC	UV Bank Control Centre	10
UVH	UV Bank (grouping of lamps)	10
BLO	Blower	15
VLV	Valve	45
GBX	Gearbox	15
MOT	Motor	15
AIR	Air Receiver	10
COM	Air Compressor	10
TNK	Tank Structure	30
AIC	Air Conditioning Unit	15
BLG	Building Structure	50
PMP	Pump	15
HAR	Hand Rails	25

[redacted]

STT	Structure	50
CHL	Channel Structure	20
CHM	Chamber Structure	20
CON	Conveyor	10
RAD	Radio	10
CRN	Crane	20
HEX	Heat Exchanger	30
DBD	Distribution Board	30
BUB	Busbar	50
CBR	Circuit Breakers	45
UPS	Uninterruptible Power Supply	15
COT	Controller	15
MAC	Macerator (Comminutor)	20
PIS	Pipe Support	50
CTF	Current Transformer	45
VOT	Voltage Transformer	45
ALT	Alternator	20
BAT	Battery Bank	20
CSM	Cooling System	10
ENG	Engine	15
BTU	Battery Charging / Tripping Unit	10
LVC	Low Voltage Components	20
TRF	Transformer	45
COD	Conductor	50
INS	Insulator	50
MCB	MV Circuit Breaker	50
AIT	Analysis Indicator Transmitter	15
CIT	Conductivity Indicator Transmitter	15
DIT	Dissolved Oxygen Indicator Transmitter	15
FIT	Flow Indicator Transmitter	15
FS_	Flow Switch	15
GIT	Turbidity Indicator Transmitter	15
LIT	Level Indicator Transmitter	15
OIT	pH Indicator Transmitter	15
PG_	Pressure Glass/Viewing device	15
PIT	Pressure Indicator Transmitter	15
PP_	Pressure Transmitter	15
PS_	Pressure Switch	15
TT_	Temperature Transmitter	15
VT_	Vibration Transmitter	15
ZS_	Position Switch	15
ZSH	Position Switch High	15
ZSL	Position Switch Low	15
SOL	Solar Panel	

[redacted]

HEA Heater / Heath Element

[redacted]

CHANGE LIST				
PAGE	**REASON FOR CHANGE**	**VER.**	**REVIEWER**	**DATE**
All	Original development	0		
	Changes on Master Data Structure	1	Zamuxolo Tutu	

Approved by: [redacted] **Signature:** _____

Manager: E&AM **Date:** _____

[redacted]

STANDARD SPECIFICATION FOR DOUBLE FLANGED BUTTERFLY VALVES FOR INLINE USE ON TRUNK MAINS

W&S-BW-01: NOVEMBER 2013

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD	Water & Sanitation Department Bulk Water Branch
	Date Approved: 29 November 2013
	Section Approval: [redacted]
	Branch Approval: [redacted]

[redacted]

[redacted]

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[redacted]

Table A 7
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ANNEXURE A: 9

[redacted]

STANDARD SPECIFICATION FOR DOUBLE FLANGED BUTTERFLY VALVES FOR IN-LINE USE ON TRUNK MAINS

1 SCOPE

This specification deals with the supply delivery and offloading of double flanged butterfly valves with nominal diameters of 100mm to 2000mm, for inline use on trunk mains, being supplied individually or as part of a contract.

This specification must be read in conjunction with the Project Specification if applicable, which deals with the specific requirements of the project for which the valves are intended.

2 NORMATIVE REFERENCES

These normative references are cited at the appropriate places in the text and the publications are listed below.

SANS 564 – Rubber insertion sheeting

SANS 1123 – Pipe Flanges

SANS 1217 – Internal and external organic coating protection for buried steel pipelines

SANS 1849 –Butterfly valves for general purpose

SANS 10064 – The Preparation of steel surfaces for coating

ISO 8501-1 – Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness

3 DEFINITIONS

Resilient-seal refers to the valve sealing being accomplished by means of a moulded elastomeric material (natural or synthetic rubber or other compound) retained in the disc and compressed by closing of the disc.

Double flange refers to a valve pattern having flanged ends for connection to pipe flanges by bolting, thus enabling the pipework on one side to be dismantled while the valve is closed under full pressure

Project Specification refers to the particular application and requirements dictated by the project for which the valve is intended. This is a separate and unique document, the requirements of which take precedence over this Standard Specification.

Schedule refers to the list of valves to be priced specifying their sizes, pressure ratings and flange drilling (being either imperial or metric.)

Tight shut off shall mean no leakage past the sealing faces when the valve is in the closed position

4 REQUIREMENTS

The butterfly valves shall conform to the requirements of SANS 1849 with the following additional requirements.

4.1 Type

The valves shall be double flanged resilient seal tight shut off valves with the seal attached to the blade of the valve.

[redacted]

4.2 Nominal Size
The valve sizes shall be as specified in the Schedule.

4.3 Pressure Rating
Unless otherwise specified in the Schedule and/or Project Specification, the valves shall be suitable for operating at a maximum working pressure of 1,2MPa.

4.4 Temperature Rating
Unless otherwise specified in the Schedule, the valves shall be suitable for operating within a temperature range of 0^{0} C - 20^{0} C.

4.5 Dimensions and tolerance of body ends
4.5.1 Flange Dimensions
The body ends shall be flanged and drilled off centre-line for either imperial use or metric use, as stated in the Schedule and/or Project Specification and in accordance with the following tables:

Imperial:
- Table A attached hereto for working pressures up to 1.2 MPa
- Table B attached hereto for working pressures greater than 1.2 MPa, up to 2.5 MPa

Metric
- SANS 1123 Table 1000/1B for working pressure up to 1.0 MPa
- SANS 1123 Table 1600/1B for working pressures greater than 1.0 MPa, up to 1.6 MPa
- SANS 1123 Table 2500/1B for working pressures greater than 1.6 MPa, up to 2.5 MPa

4.5.2 Face-to-face dimensions
The face to face dimensions shall be in accordance with SANS 1849 Table 5: Double Flanged Long.

4.5.3 Tolerances on face-to-face dimensions
Tolerances on the face-to-face dimensions shall be in accordance with Table 6 of SANS 1849.

4.6 Design
4.6.1 General
The valves shall be suitable for flow in either direction and shall be designed for tight shut-off in either direction at the maximum working pressure.

4.6.2 End Flanges
End flanges shall be cast integral with the body.

4.6.3 Shaft
Shafts shall be of either continuous or a stub-shaft design configuration. Stub shafts shall extend into the disc hub for a distance of at least 1.5 times the shaft diameter and shall not protrude from the hubs i.e. not exposing the shaft ends.

Shafts shall be securely attached to the disc by means of keys, dowel pins, taper pins, or any combination of the three.

The main shaft shall be of stainless steel and shall be offset from the centre line of the disc so as not to pass through the seat. The design shall be such that the seal is compressed evenly and that scuffing of the seal is minimised by means of eccentricities and offsets to the disc closing action against the seat. The shaft shall be horizontal when the bolted to a horizontal pipe.

[redacted]

4.6.4 Seating and seals

4.6.4.1 Seating

The seat may be stainless steel welded on, removable or form an integral part of the body with a high-alloy Ni-Cr weld overlay.

Only low Carbon austenitic stainless steel shall be used for the welded on seat. The Carbon content shall be 0.03% or less. After completion of the weld, the valve shall be heated and allowed to cool slowly to reduce stresses built up during the welding process

Removable seats, where offered, shall be either stainless steel or bronze mechanically held in place with either stainless steel or bronze studs respectively screwed into the body.

Where a weld overlay is offered, the percentages of Nickel and Chromium making up the alloy shall be stated in Annexure A.

4.6.4.2 Seals

An adjustable seal of approved resilient material shall be fixed to the edge of the disc by means of a solid stainless steel or bronze ring held in place respectively by either stainless steel or bronze screws. The seal shall have an O-ring, dovetail music note, wedge, tadpole, dumb-bell or other cross-sectional shape to the approval of the Engineer to ensure that it is firmly locked in between the disk and the retaining ring. It shall not be flat or require adhesives for bonding.

4.6.5 Disc

The valves shall be so designed that the disc when in an open position will be clear of the lining of the pipes, fittings and specials manufactured in accordance with the Council's Specification W&S-BW 011.

4.7 Operation

4.7.1 General

The operating shaft shall be vertical and the valve shall be capable of being closed by one man against the maximum unbalanced pressure.

The hand wheel shall be of an appropriate diameter and fitted horizontally above the top of the end flanges for unhindered wheel operation. The hand wheel shall have the wording "OPEN" and "CLOSE" together with directional arrows legibly cast on the upper surface of the hand wheel.

The gearbox shall not be an integral part of the main body, but shall be a separate unit bolted to the main body in such a manner as to prevent any water leaking past the main shaft seal from entering the gearbox. Seal retaining rings shall be of stainless steel. A torque slip device shall be fitted such that the hand wheel slips automatically in positive steps to limit the maximum possible torque to the gearbox. A shear pin is not acceptable.

4.7.2 Direction of closing

The valves shall be anti-clockwise closing.

4.7.3 Position Indicators

Robust, rigid position indicators shall be provided on the gearbox to show clearly the fully open, fully closed and intermediate positions.

4.8 Materials

4.8.1 Valve Materials

The valve body and disc shall be manufactured out of either Spheroidal graphite iron or Carbon steel.

[redacted]

4.8.2 Nuts, Bolts, Washers and Jointing Material

The valves shall be supplied complete with nuts, bolts and rubber insertion jointing material to SANS 564. The minimum thickness of jointing material shall be 3,2 mm. Fasteners of 12 mm and smaller shall be of grade 316 stainless steel and fasteners larger than 12 mm shall be hot-dip galvanised.

4.9 Protection Against Corrosion

4.9.1 Coating System

All exposed internal and external surfaces of the valve body and disc shall be protected with a water resistant, non-toxic and non-tainting fusion bonded, powder epoxy coating to a minimum thickness of 300 microns and shall be in accordance with SANS 1217. Pre-heating is needed to achieve the required thickness.

If the valve disc and/or valve body is too large for the fusion bond process to be applied and this is certified (in writing to the Engineer) by the specialist applicator, then the following alternative corrosion protection system shall be applied:

- Three coats of a low solvent, two component, high solids, polyamine cured, potable water epoxy (Dulux Sigmaguard EHB, Scotchkote Epoxy Coating KSIR 88, Ameron Amercoat 385 or equivalent). Final dry film thickness shall not be less than 300 micron.

4.9.2 Surface Preparation

Surface imperfections, sharp edges etc. shall be removed prior to abrasive blasting.

Before coating, all surfaces to be coated shall be abrasive blast cleaned to a SA 3 finish to ISO 8501-1. The surface profile shall be within the range 50 to 100 micron. The abrasive shall comply with SANS 10064.

Immediately after cleaning (within 4 hours) the first coat shall be applied.

4.9.3 Coating Application

Paint shall not be applied over any surface containing traces of grit, moisture, grease, oil etc. or corrosion products of any kind.

Paint surfaces which are to be over coated shall be hard and dry before over coating, unless the supplier states otherwise. The dry film thickness shall be measured using a non-destructive thickness gauge such as "Mikrotest" or equivalent.

Where painting of machined surfaces is not possible or advisable, these surfaces shall be coated with an approved proprietary anti-corrosion compound capable of giving 12 months protection under operating conditions. Shaft ends shall be treated similarly and not painted.

In order to avoid incompatibility between paint coats due to variations in formulation, the different coats in any one-paint system shall be provided from the same manufacturer.

4.9.4 Quality Control

The Contractor shall adopt an acceptable quality control procedure on the coating application to ensure compliance with the Specification which shall at least include inspections at the following stages:

- After surface preparation;
- After first coat application; and
- After the final coat has been applied.

[redacted]

If the coating is to be done outside the Cape Peninsula area, the inspection shall be witnessed by an independent competent inspector appointed by the Contractor but approved by the Engineer, and a report of the inspection compiled. If the metal coating is done in the Cape Peninsula area, the Engineer is to witness the inspection.

4.9.5 Pinhole Testing

The coating shall undergo holiday detection over the full surface of the valve in accordance with SANS 1217.

4.9.6 Coating Repair

Where the paint coating has been damaged during transportation and offloading or by any other means whatever, it shall be repaired as follows:

- Rust spots shall be removed and cleaned by means of wire brush or emery paper to a bright finish and the surrounding paint which is intact shall be feathered for a distance of 20 mm beyond the damaged area; and
- Spot priming and repair shall consist of a suitable system recommended by the original coating supplier.

4.10 Technical Data

The data sheet in Annexure A shall be completed in detail.

In addition to Annexure A, the following shall be submitted with the tender:

- Printed technical brochure/ data sheet providing full technical details of the valves; and
- Drawings showing valve dimensions, the seal cross section with details of the seat arrangements and thrust bearing.

Omission of any of the above items may lead to disqualification of the tender.

5 Inspection and method of testing

Each valve shall be inspected in accordance with SANS 1849 in both flow directions and a test certificate certifying that it complies with the requirements of this Specification supplied. The cost of all witnessing of tests by the Engineer, inspections and certification shall be included in the Tender price. Provision shall be made in the tender price for a one-day visit by the Engineer or Engineer's Representative to witness the testing of the valve. The test certificate and corrosion protection inspection report shall be forwarded to the Engineer before delivery of the valve.

6 Marking

Each valve shall have a brass plate firmly affixed to the body with the following information stamped or engraved thereon;

- Manufacturer
- Order Number
- Date of Order
- Size
- Pressure Rating
- Body and Disc Material
- Serial Number

TABLE A

FLANGE DIMENSIONS FOR A WORKING PRESSURE OF 1,2 MPa

(AMENDED AUGUST 1987)

1	2	3	4	5	6	7	8	9
NOMINAL DIAMETER OF PIPE mm	DIAMETER OF FLANGE mm	DIAMETER OF BOLT CIRCLE mm	NUMBER OF BOLTS	BOLT DESIGNATION	DIAMETER OF BOLT HOLES mm	THICKNESS OF FLANGE		
						CAST IRON mm	WROUGHT STEEL mm	FORGED OR CAST STEEL (VALVES) mm
75	185	146,05	4	M16	18	19	12	14
100	215	177,80	4	M16	18	19	12	17
150	280	234,95	8	M16	18	21	12	17
200	337	292,10	8	M16	18	22	15	19
230	370	323,85	8	M16	18	22	15	19
305	455	406,40	12	M20	22	25	20	22
380	550	495,30	12	M24	26	25	22	25
460	640	584,20	12	M24	26	25	25	29
535	735	673,10	16	M24	26	35	28	32
610	825	755,65	16	M24	26	35	32	35
685	910	844,55	20	M24	26	35	35	38
760	995	927,10	20	M30	33	38	40	41
840	1090	1 016,00	20	M30	33	41	45	41
915	1 175	1 092,20	24	M30	33	41	50	44
1 065	1 335	1 250,95	28	M30	33	44	55	48
1 220	1 490	1 409,70	32	M30	33	48	60	51
1 370	1 680	1 593,85	44	M45	48	51	75	
1 525	1 855	1 758,95	52	M45	48		80	
1 675	2 030	1 930,40	52	M45	48		85	
1 830	2 195	2 095,50	60	M45	48		90	

NOTE: The above table is based upon BS10: 1962 Table D, for sizes up to and including 1 0675 mm nominal diameter, and AWWA Manual M11, for sizes greater than 1 065 mm nominal diameter.

[redacted]

In addition to the above, one flange of the **Metric** valves shall be clearly marked at the top of the flange with a single set of machined notches at least 3mm wide, 3mm deep and 8mm long as follows:

- One notch - 1.0 MPa operating pressure
- Two notches - 1.6 MPa operating pressure
- Three notches - 2.5 MPa operating Pressure

7 Preparation for despatch

The jointing surfaces shall be protected and the body ends covered with wooden flanges of at least 10mm thickness before despatch.

[redacted]

TABLE B

FLANGE DIMENSIONS FOR A WORKING PRESSURE OF 2,5 MPa (AMENDED MAY 1987)

1	2	3	4	5	6	7	8	9
NOMINAL DIAMETER OF PIPE mm	DIAMETER OF FLANGE mm	DIAMETER OF BOLT CIRCLE mm	NUMBER OF BOLTS	BOLT DESIGNATION	DIAMETER OF BOLT HOLES mm	THICKNESS OF FLANGE		
						CAST IRON mm	WROUGHT STEEL Mm	FORGED OR CAST STEEL (VALVES) mm
75	205	165,10	8	M16	18	19	16	16
100	20	190,50	8	M16	18	22	19	19
150	305	260,35	12	M20	23	25	22	22
230	405	355,60	12	M24	27	29	29	25
305	490	438,15	16	M24	27	32	32	29
380	580	520,70	16	M27	30	35	38	32
460	675	609,60	20	M30	33	38	44	35
535	760	698,50	24	M30	33	41	51	38
610	850	781,05	24	M33	36	44	57	41
685	935	857,25	24	M36	39	48	60	48
760	1 015	939,80	28	M36	39	51	70	51
840	1 095	1 016,00	32	M36	39	54	70	54
915	1 190	1 104,90	32	M36	39	57	80	57
1 065	1 355	1 270,00	36	M36	39	64	90	64
1 220	1 530	1 441,45	40	M42	45	67	100	67
1 370								
1 525								
1 675								
1 830								

The above table is based upon BS10: 1972 Table F.

[redacted]

ANNEXURE A

TECHNICAL DATA

1. Material for valve body and disc (Clause 4.8.1)

.....

2. Seat: (Clause 4.6.4)

REMOVABLE	
WELDED IN	
INTEGRAL WITH BODY	

Tick as appropriate

2.1. Seat material where removable seat is offered

.....

2.2. Seat material where welded in seat offered

.....

2.3. Overlay constituents where integral seat offered

.....

3. Material for seal retaining ring (Clause 4.6.4)

.....

4. Material for seal and shape of cross section (Attach drawing) (Clause 4.6.4)

.....

5. Details of eccentricities and offsets to the disc closing action against the seat (Clause 4.6.3)

.....

6. Details of thrust bearings and attachment (Attach drawing) (SANS 1849 Clause 4.6.4)

.....

7. Will disc in fully open position clear inside pipe lining as specified? (Clause 4.6.5)

.....

8. Corrosion protection system, supplier and applicator (Clause 4.9.1)

.....

9. Quality control and competent inspector's name (Clause 4.9.4)

.....

Signature of Tenderer..... Date .....

[redacted]

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

WATER AND SANITATION DEPARTMENT
BULK WATER BRANCH
W&S-BW010: 1995

Rev.: 26 MAY 2011

STANDARD SPECIFICATION FOR MECHANICAL TYPE STRAIGHT COUPLINGS, STEPPED COUPLINGS AND FLANGE ADAPTORS

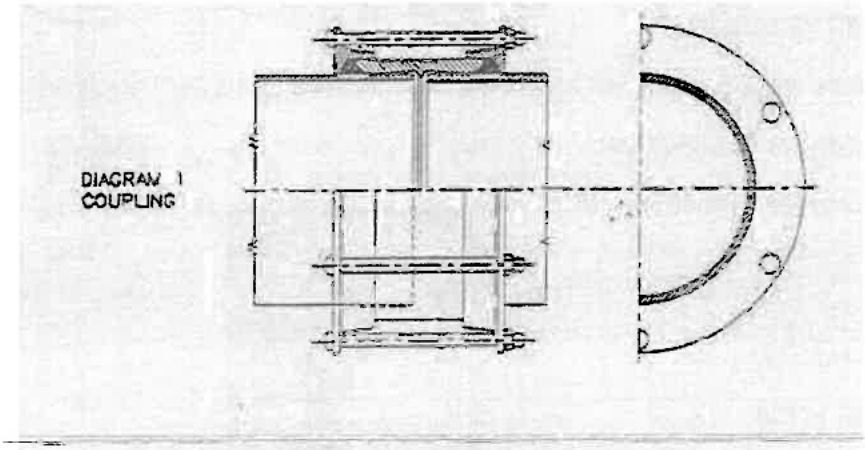
1. SCOPE

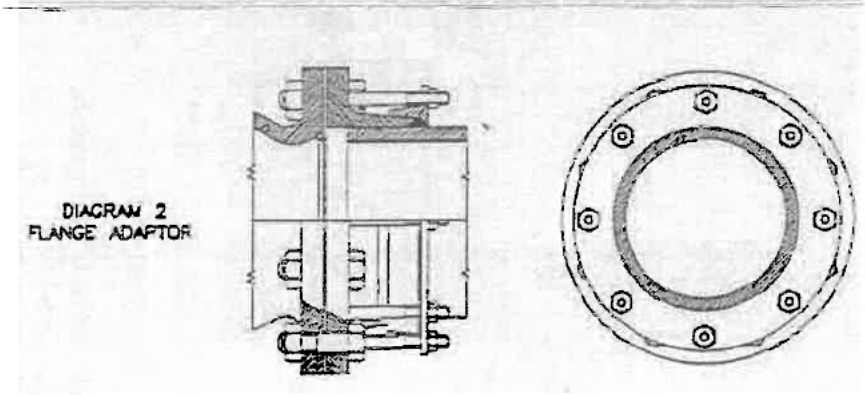
This standard specifies the requirements for mechanical type straight couplings, stepped couplings and flange adaptors for use with steel, cast-iron, fibre-cement and uPVC pipe.

2. DESIGN

2.1. GENERAL

The couplings and flange adaptors shall be of the sleeve type having joints consisting of a resilient sealing ring which is compressed, simultaneously onto the end of the sleeve and the circumference of the pipe, by means of a compression ring and nuts and bolts or studs and nuts. In the case of couplings the tightening of the nuts and bolts shall draw the compression rings, at either end, together whereas in the case of flange adaptors, tightening of the nuts and studs shall draw the single compression rings towards the flange (see diagram 1 and 2 below).





2.2. SLEEVE

The dimensions of the sleeve shall be as given in the following table:

1	2	3
OUTSIDE DIAMETER OF PIPE mm	DIMENSIONS OF SLEEVE	
	MINIMUM LENGTH mm	MINIMUM AVERAGE THICKNESS mm
Up to 130	102	6,4
131 to 220	102	7,2
221 to 330	102	8,7
331 to 720	178	8,7
721 to 1 220	178	11,1
1 221 to 1 830	178	14,3
1 831 upward	254	14,3

2.3. CENTRE REGISTER

Unless otherwise specified in the Schedule, centre registers shall not be provided.

2.4. ANGULAR DEFLECTION

Each coupling shall allow for an angular deflection as given in the following table:

1	2
OUTSIDE DIAMETER OF PIPE mm	ANGULAR DEFLECTION DEGREES
Up to 600	6
601 to 750	4
751 to 900	4
901 to 1 200	3
1 201 to 1 800	2

NOTE: the angular deflection for flange adaptors shall be half the corresponding amount shown in the above table.

[redacted]

2.5. FLANGES

The flanges of flange adaptors shall be in accordance with the dimensions given in Table A attached hereto. The mating face shall be machined.

2.6. BOLTS

The diameter of the bolts shall be either 12 or 16 mm.

3. MATERIAL

All couplings and flange adaptors shall be manufactured from steel plate complying with the requirements of SABS 719, except that sizes for outside pipe diameters up to 170 mm may be manufactured from malleable or ductile iron.

4. SEALING RINGS

The sealing rings shall comply with the requirements of SANS 974.

5. WORKING PRESSURE

Unless otherwise specified in the Schedule, the couplings and flange adaptors shall be suitable for working pressures up to 1,2 MPa.

6. WELDING

All welding shall comply with the requirements of SANS 044, particular attention being given to the welding of studs which shall not be welded to the surface on one side of the flange only but shall be taken through the flange and be welded on both sides.

7. PROTECTION AGAINST CORROSION

7.1. The sleeves shall be given two coats of self-etching primer.

7.2. All bolts shall be electro-galvanised.

8. MARKING AND PACKING

8.1. MARKING

All couplings shall be marked on the outside of the sleeve with the following information:

8.1.1. Nominal Diameter

8.1.2. Working pressure in MPa.

8.2. PACKING

All couplings and flange adaptors shall be packed complete with all necessary nuts, bolts and sealing rings. The mating faces of flange adaptors shall be protected before despatch.

[redacted]

TABLE A

FLANGE DIMENSIONS FOR A WORKING PRESSURE OF 1,2 MPa (AMENDED AUGUST 1987)

1	2	3	4	5	6	7	8	9
NOMINAL DIAMETER OF PIPE mm	DIAMETER OF FLANGE mm	DIAMETER OF BOLT CIRCLE mm	NUMBER OF BOLTS	BOLT DESIGNATION	DIAMETER OF BOLT HOLES mm	THICKNESS OF FLANGE		
						CAST IRON mm	WROUGHT STEEL mm	FORGED OR CAST STEEL (VALVES) mm
75	185	146.05	4	M16	18	19	12	14
100	215	177,80	4	M16	18	19	12	17
150	280	234,95	8	M16	18	21	12	17
200	337	292,10	8	M16	18	22	15	19
230	370	323,85	8	M16	18	22	15	19
305	455	406,40	12	M20	22	25	20	22
380	550	495,30	12	M24	26	25	22	25
460	640	584,20	12	M24	26	25	29	29
535	735	673,10	16	M24	26	35	28	32
610	825	755,65	16	M24	26	35	32	35
685	910	844,55	20	M24	26	35	35	38
760	995	927,10	20	M30	3	38	40	41
840	1090	1 016,00	20	M30	33	41	45	41
915	1 175	1 092,20	24	M30	33	41	50	44
1 065	1 335	1 250,95	28	M30	33	44	55	48
1 220	1 490	1 409,70	32	M30	33	48	60	51
1 370	1 680	1 593,85	44	M45	48	51	75	
1 525	1 855	1 758,95	52	M45	48		80	
1 675	2 030	1 930,40	52	M45	48		85	
1 830	2 195	2 095,50	60	M45	48		90	

NOTE: The above table is based upon BS10: 1962 Table D, for sizes up to and including 1 0675 mm nominal diameter, and AWWA Manual M11, for sizes greater than 1 065 mm nominal diameter.

[redacted]

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

WATER AND SANITATION DEPARTMENT
BULK WATER BRANCH
W&S-BW015: 1993

Rev.: 26 MAY 2011

STANDARD SPECIFICATION FOR GATE VALVES

1. SCOPE

This specification covers the manufacture of cast-iron, cast steel and spheroidal graphite iron gate valves from 50 mm to 300 mm nominal diameter with flanged, spigotted or socketted joints.

2. WORKING PRESSURES

The valves shall be suitable for working pressures of up to either 1,2 MPa or 2,5 MPa as specified in the Schedule.

3. DESIGN

3.1 General

The valves shall comply with the requirements of SANS 664: 1989 (as amended) Class 16 Type B, for working pressures up to 1,2 MPa and with the requirements of SANS 191: 1972 (as amended) Class 25 Type B, for working pressures up to 2,5 MPa together with the following additional requirements:

3.1.1 the ends of the valves shall be flanged, or spigotted, or socketted to suit uPVC pipes, as specified in the Schedule;

3.1.2 the spindles shall be non-rising;

3.1.3 the spindles shall be fitted with caps unless otherwise specified in the Schedule;

3.1.4 the direction of closing shall be anti-clockwise;

3.1.5 the body ends shall be flanged and drilled off centre-line and shall in all respects be in accordance with either:

* Table A attached hereto for working pressures up to 1,2 MPa; or
* SANS 1123-2003, for working pressures up to 1,6 MPa; or
* Table B attached hereto for working pressures of 2,5 MPa,

as specified in the Schedule;

3.1.6 the design of all valves shall be such that they may be mounted in any position;

3.1.7 valves for working pressures above 1,2 MPa shall be fitted with ball-bearing spindle thrust collars;

3.2 Wedge Gate Valves

3.2.1 valves of 225 mm nominal diameter, for working pressures above 1,2 MPa, and all valves of 300 mm nominal diameter shall be fitted with a spur reduction gear having an advantage of not less than 2:1;

3.2.2 the gate and spindle lugs shall be machined;

3.2.3 the seat rings shall be pinned;

[redacted]

3.2.4 the gland packing shall comply with the requirements of BS 4371 Types J, K or L (consisting of virgin Teflon or Aramid fibres), shall be strictly non-toxic and suitable for this application;

3.2.5 the gland shall be secured to the stuffing box with bronze T-bolts and nuts in accordance with SANS 664: 1989 (as amended).

3.3 **Resilient seal valves**

3.3.1 The materials for construction shall be

Body, bonnet, gate	-	Spheroidal graphite iron and gland to SABS 936 SG38
Spindle	-	Stainless steel to BS 970 Part 4: 410S21 or 302S25
Spindle nut	-	Aluminium bronze
Corrosion protection	-	Internal and external sintered powder epoxy coating in accordance with SANS 1217, Type 2.

3.3.2 The valve shall have a straight, unobstructed body passage and the gate shall be completely clear of the waterway in the fully open position;

3.3.3 A double O-ring spindle seal with dirt cover shall be provided;

3.3.4 An O-ring seal shall be provided between the body and bonnet.

3.3.5 A backseal shall be provided to permit replacement of the spindle seal with the valve under pressure;

3.3.6 The seal shall totally cover the gate and be firmly bonded such that it does not become torn, loose or detached and that there is no leakage past the gate during tests or normal operation;

3.3.7 The valve shall be capable of withstanding a torque of 700 Nm applied to the spindle in both opening and closing directions without damage to any of the components;

3.3.8 Detailed drawings as well as certification by an independent body of mechanical properties and chemical analysis of components shall be made available upon request.



TABLE A

FLANGE DIMENSIONS FOR A WORKING PRESSURE OF 1,2 MPa (AMENDED AUGUST 1987)

1	2	3	4	5	6	7	8	9
NOMINAL DIAMETER OF PIPE mm	DIAMETER OF FLANGE mm	DIAMETER OF BOLT CIRCLE mm	NUMBER OF BOLTS	BOLT DESIGNATION	DIAMETER OF BOLT HOLES mm	THICKNESS OF FLANGE		
						CAST IRON Mm	WROUGHT STEEL mm	FORGED OR CAST STEEL (VALVES) mm
75	185	146,05	4	M16	18	19	12	14
100	215	177,80	4	M16	18	19	12	17
150	280	234,95	8	M16	18	21	12	17
200	337	292,10	8	M16	18	22	15	19
230	370	323,85	8	M16	18	22	15	19
305	455	406,40	12	M20	22	25	20	22
380	550	495,30	12	M24	26	25	22	25
460	640	584,20	12	M24	26	25	25	29
535	735	673,10	16	M24	26	35	28	32
610	825	755,65	16	M24	26	35	32	35
685	910	844,55	20	M24	26	35	35	38
760	995	927,10	20	M30	33	38	40	41
840	1 090	1 016,00	20	M30	33	41	45	41
915	1 175	1 092,20	24	M30	33	41	50	44
1 065	1 335	1 250,95	28	M30	33	44	55	48
1 220	1 490	1 409,70	32	M30	33	48	60	51
1 370	1 680	1 593,85	44	M45	48	51	75	
1 525	1 855	1 758,95	52	M45	48		80	
1 675	2 030	1 930,40	52	M45	48		85	
1 830	2 195	2 095,50	60	M45	48		90	

NOTE: The above table is based upon BS10: 1962 Table D, for sizes up to and including 1 065 mm nominal diameter, and AWWA Manual M11, for sizes greater than 1 065 mm nominal diameter.

[redacted]

TABLE B

FLANGE DIMENSIONS FOR A WORKING PRESSURE OF 2,5 MPa (AMENDED MAY 1987)

1	2	3	4	5	6	7	8	9
NOMINAL DIAMETER OF PIPE mm	DIAMETER OF FLANGE mm	DIAMETER OF BOLT CIRCLE mm	NUMBER OF BOLTS	BOLT DESIGNA-TION	DIAMETER OF BOLT HOLES mm	THICKNESS OF FLANGE		
						CAST-IRON mm	WROUGHT STEEL Mm	FORGED OR CAST STEEL (VALVES) mm
75	205	165,10	8	M16	18	19	16	16
100	230	190,50	8	M16	18	22	19	19
150	305	260,35	12	M20	23	25	22	22
230	405	355,60	12	M24	27	29	29	25
305	490	438,15	16	M24	27	32	32	29
380	580	520,70	16	M27	30	35	38	32
460	675	609,60	20	M30	33	38	44	35
535	760	698,50	24	M30	33	41	51	38
610	850	781,05	24	M33	36	44	57	41
685	935	857,25	24	M36	39	48	60	48
760	1 015	939,80	28	M36	39	51	70	51
840	1 095	1 016,00	32	M36	39	54	70	54
915	1 190	1 104,90	32	M36	39	57	80	57
1 065	1 355	1 270,00	36	M36	39	64	90	64
1 220	1 530	1 441,45	40	M42	45	67	100	67
1 370								
1 525								
1 675								
1 830								

NOTE: The above table is based upon BS10: 1972 Table F.

[redacted]

STANDARD SPECIFICATION FOR ELECTROMAGNETIC FLOW METERS

1. SCOPE

This standard gives the requirements for electromagnetic flow meters suitable for the measurement of water flow in pipes of nominal diameters from 100 mm to 2 000 mm inclusive.

2. GENERAL

The flow meters shall consist of a sensing unit, a transmitting unit and a receiving unit all suitable for operation from a 230V ±15% 50Hz power supply. They shall be capable of being linked to the Council's existing telemetry system. They shall incorporate automatic zero and span stability and have an integral zero and span check. Full lightning protection with automatic reset shall be incorporated.

3. SENSING UNIT

3.1. GENERAL

Unless otherwise stated in the Schedule of Quantities, the sensing unit shall be capable of operating at an internal pressure of 1,2 MPa. If specified in the Schedule of Quantities, or if necessary due to design considerations requiring the use of a sensing unit of smaller nominal diameter than the pipe in order to accommodate the specified flow range, the sensing unit shall be provided with two reducers, both ends flanged, manufactured in accordance with the requirements of the Council's Standard W&S-BW011 with the exception that the angle of taper may be modified to suit the design requirements of the sensing head. The magnetising current in Amps and the coil exciter frequency in Hz must be stated in the tender.

3.2. METERING TUBE

Unless otherwise specified in the Schedule of Quantities, the metering tube shall have flanged ends complying with the requirements of SANS 1123-2003, for direct insertion of the tube in any attitude into the pipeline. It shall be lined with an approved hard rubber, have 316 stainless steel electrodes and be provided with earthing rings.

3.3. HOUSING

The housing shall be such as to permit the unit to be installed in an underground chamber and shall meet the requirements for IP68 protection against environmental conditions. The IP68 protection shall be removable, so as to permit fault finding and the replacement of signal cables in the event of damage.

3.4. FASTENERS

The flowmeters shall be supplied complete with fasteners (nuts, bolts and washers).

Fasteners of 12 mm and smaller shall be of grade 316 stainless steel and fasteners larger than 12 mm shall be hot-dip galvanized.

[redacted]

4. **TRANSMITTING UNIT**

The transmitting unit shall be contained in a case designed for wall mounting and shall meet the requirements for IP67 protection against environmental conditions.

The flowmeter shall have an isolated 4-20mA output, directly proportional to flow, for linking to the telemetry system. Additional to the 4-20mA output, the transmitting unit shall have the capability to convert the 4-20mA output to a Modbus signal to provide direct communication to the City's communication systems.

The tenderer shall indicate whether a separate signal loop with 4-20mA output, directly proportional to flow, can be provided for logging of the meter without interfering with the existing signal configuration.

5. **RECEIVING UNIT**

The receiving unit shall contain a chart recorder with a fibre-tip pen system, which shall record the rate of flow as a continuous line on a seven day circular chart calibrated in kℓ/h or Mℓ/d, as appropriate, and an integrating totaliser calibrated in kℓ or Mℓ, also as appropriate. The totaliser shall not be re-settable. The unit shall be contained in a case suitable for wall or panel mounting and shall meet the requirements for IP65 protection against environmental conditions. Each unit shall be provided with 100 charts. The receiving unit shall be MODBUS compatible and ready.

6. **ACCURACY**

The overall accuracy of the meters shall be ± 0,5% of actual reading with a water velocity through the metering tube of 3± 0,1 m/s. The meters shall be calibrated at 10%, 25%, 50%, 75% and 100% of the designed maximum rate of flow and these calibrations should be traceable to internationally accepted standards. A calibration certificate recognised by the South African National Calibration Service must be provided for each meter. Full details of the calibration procedure shall be submitted with the tender.

7. **COMMISSIONING**

Unless otherwise specified in the Schedule of Quantities, the supplier will be required to provide the signal cables between the units and to commission the meters after installation by the Council. The signal cables shall each be 10 m in length, and shall be removable, so as to permit it's replacement in the event of damage.

8. **VERIFICATION**

Electromagnetic flow meters shall comply with meter verification. Verification shall be done using an external meter verificator (verification device) without the need to remove the flow meter from its pipeline installation point. The verification shall be performed using an external certified device, which shall be calibrated and have traceable certification from the flow meter manufacturer. The verificator shall be subjected to an annual calibration with a calibration certificate provided. Clamp-on check meters and software verification shall not be permitted as adequate installation conditions for a clamp-on meter might not be available. This stand-alone tool shall be able to check and measure a number of parameters in the flow sensor and transmitter such as outputs, insulation and magnetism of the flow meter that can affect the accuracy and integrity of the meter of which the results shall be presented from the device's verification certificate.

[redacted]

Approved by: [redacted]	**Signature:** [redacted]
Head: Infrastructure and Project Implementation	**Date:** 19 September 2023

[redacted]

General specification

General Corrosion Protection
Specification number: SPE-JJ-0003

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Specification no.		SPE-JJ-0003			
Rev	**Date**	**Revision details / status**	**Author**	**Reviewer**	**Approver**
0	2021/11/11	First Issue	[redacted]		
Signature					

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1 Scope

This Specification covers the painting and corrosion protection of plant, equipment in pump stations and water and wastewater treatment works and pipelines exposed to environments with variable corrosive tendencies.

Interpretations and variations of this Specification are set out in the Amendments of this Specification.

2 Normative References

2.1 Supporting Specifications

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

(a) Amendments to this Specification;

Equipment, materials and operational methods shall comply with the latest edition of the relevant SANS, ISO, AS, BS, DIN or equivalent American Standard as shown in Annexure A.

3 Definitions and Abbreviations

3.1 Definitions

In this Specification the following shall have the meaning given:

(a) **Coat:** A single uniform film of corrosion protection material applied to a substrate for corrosion protection purposes.

(b) **Layer:** A uniform protective film of corrosion protection material applied to plant, equipment and piping in a specified manner consisting out of multiple coats.

(c) **System:** A corrosion protection coating or lining consisting of multiple coats and/or layers, the type of coat, the number of coats and their thickness, the method of application and the requirements of the complete system.

(d) **Coating:** A system on the outside of plant, equipment and pipework. However, certain international specifications referred to in this specification (e.g. AWWA specifications) use the term 'coating' to refer also to internal pipe protection and where these specifications are being referred to their terminology is used.

(e) **Lining:** A system on the inside of plant, equipment and piping.

(f) **Dis-bonded area:** An area of coating or lining that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.

(g) **Un-bonded area:** An area of coating or lining which at no stage adhered to the steel substrate.

(h) **Water path:** The shortest distance along the surface of an object embedded in concrete but exposed to water measured along the concrete interface.

(i) **Holiday:** A discontinuity in a coating or lining which exhibits electrical conductivity when exposed to a specific voltage.

(j) **Abrasive blast cleaning:** The process of projecting a stream of abrasive particles at high velocity towards a surface for the purpose of removing contaminants from that surface and to produce a textured surface which will increase the surface area and thus increase adhesion of the coating.

(k) **Dry film thickness (DFT):** The thickness of a coating or lining after it is hard dry.

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(l) **Electrical insulation defect (EID):** Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

(m) a low-voltage, wet-sponge detector, or

(n) a high-voltage, sparking detector,

operated in each case within the parameters specified.

Note: EID's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays.

(o) **Fusion bonded epoxy (FBE):** A thermoset epoxy powder coat. (The powder is normally applied by electrostatic spray to a preheated surface. The powder normally melts, fuses and cures at a temperature of 220°C to 250°C.)

(p) **Inspector:** A person authorised by the Engineer to act as his representative in examining the work and materials and drawing such samples and carrying out such tests as may be necessary to ensure compliance with the specification.

(q) **Lot:** A number of similar or related items submitted for inspection at one time by the Contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day.

(r) **Paint:** A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied.

(s) **Pinhole:** An electric insulation defect detected by the use of a wet sponge detector (see EID).

(t) **Pot life**: The period, after the contents of the packs of a two-pack paint have been mixed together, during which the paint remains suitable for use without the addition of further solvent.

(u) **Powder coat:** A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface. A powder coat is classified as thermoplastic when the applied coat may be re-melted by heating, or as thermoset when it cannot be re-melted by heat. Low or medium density polyethylene powder is thermoplastic whilst FBE is a thermoset material.

(v) **Significant surface**: The part of the article covered or to be covered by the coating or lining and for which the coating or lining is essential for serviceability and/or appearance.

(w) **Steel**: This term embraces carbon steels, 3CR12 and all grades of stainless steels.

(x) **Water break free:** A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands surrounded by unwetted surfaces.

(y) **Wet film thickness (WFT):** The thickness of a coating or lining immediately after application and before any volatile matter has evaporated.

(z) **Quality control:** The operational techniques and activities that are employed by the Contractor to sustain the required quality of a product, process or service.

(aa) **SAHDGA:** South African Hot Dip Galvanisers Association.

(bb) **Sa:** Followed by a number refers to a photographic illustration of the standard of blast cleaning required, as shown in ISO 8501-1

(cc) **St**: Followed by a number refers to a photographic illustration of the standard of mechanical cleaning required, as shown in ISO 8501-1.

3.2 Abbreviations

The following abbreviations shall have the meaning assigned to them:

µm : Micrometre

3CR12 : A 12% chromium-containing corrosion resistant steel

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3LPE	:	Three layer high density polyethylene
ABS	:	Acrylnitrile-butadiene-styrene
Al	:	Aluminium
CI	:	Cast iron
CS	:	Cast steel
DCA	:	Die cast aluminium
DFT	:	Dry film thickness
EID	:	Electrical insulation defect
FBE	:	Fusion-bonded Epoxy
FBP	:	Fusion-bonded Polyester
FBPE	:	Fusion-bonded Polyethylene
GRP	:	Glass fibre reinforced Polyester
HDG	:	Hot-dip galvanized
HDPE	:	High Density Polyethylene
MIO	:	Micaceous Iron Oxide
MS	:	Mild steel
PC	:	Polycarbonate
PVC	:	Polyvinylchloride
QCP	:	Quality Control Plan
SG	:	Spheroidal graphite cast iron
SS	:	Stainless steel – grades 304, 304L, 316 and 316L
UV	:	Ultra Violet
WFT	:	Wet film thickness

4 Requirements

4.1 Contractor's Obligation

The requirements, material, surface preparation and corrosion protection systems prescribed in this Specification is regarded as a minimum requirement for the specific application. No deviation from this Specification shall be allowed without the written approval of the Engineer.

The Contractor is responsible for the design of the corrosion protection system and shall submit to the 333Engineer details of the material selection, surface preparation method and corrosion protection system he intends using as part of his design, including the Manufacturer's Instructions for each product and shall only proceed with the purchase of the corrosion protection materials/paints upon receipt of conformation from the Engineer.

The Contractor shall obtain written evidence from the chosen material manufacturer/supplier that the proposed materials, surface preparation method and corrosion protection system comply with the specified requirements and are suitable for the intended purposes under the specified Environmental Conditions (refer to Clause 4.3). The Contractor shall also obtain the Manufacturer's Instructions (refer

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to Clause 4.2). The written evidence and Manufacturer's Instructions shall be submitted to the Engineer for comment before commencement of the work.

In the event that no corrosion protection is specified for any Plant, equipment or pipes within the Specifications or Drawings, this Specification shall be used as a basis to agree on a corrosion protection system for the specific application.

4.2 Manufacturer's Instructions

The manufacturer's instructions shall be regarded as the recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead.

The following details shall be made available to the Engineer and the applicator:

- Brand and type of corrosion protection material;
- Mixing and thinning instructions;
- Recommended type and quantity of solvent required for thinning during application;
- Pot life of mixed product;
- Minimum and maximum recommended dry film thickness per coat;
- Minimum and maximum recommended dry film thickness per layer;
- Recommended time intervals between coats;
- Recommended minimum and maximum steel surface temperatures during application;
- Time for complete drying and curing on applicable surfaces;
- Substrate surface preparation requirements;
- Recommended primers for substrate;
- Recommended method of coating and lining application;
- Repair procedures for damaged coatings and/or linings and field joints on pipelines;
- Toxicity if in contact with water, and
- All relevant information the Supplier wishes to submit on his product.

Verbal instructions by the manufacturer's representative will not be accepted unless confirmed in writing by the Contractor.

4.3 Environmental Conditions

Environmental conditions shall be classified according to SANS 10120-3 HC. The corrosion protection system design and applied by the Contractor shall be suitable for the Environmental Conditions specified.

Unless otherwise specified in the Amendment of this Specification the Environmental Conditions shall be classified as follows:

- Mildly-corrosive: Dry, indoor/internal, above ground and ventilated conditions, not within 5km from the coastline or polluted industrial area. Relative humidity below 70%.
- Severely corrosive: Submerged, splash-zone, underground, very moist conditions, or within 5km from coastline or polluted industrial area, or in waste water works, or close to electrical power lines. Relative humidity above 85%.
- Medium Corrosive: All other conditions not included in the abovementioned definitions.

Notwithstanding the abovementioned information the Contractor shall satisfy himself of the environmental conditions on Site and design the final corrosion protection systems accordingly.

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4.4 Workmanship

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified supervisor.

Similarly all repair work at Site shall be done by competent personnel under the supervision of a qualified supervisor.

4.5 Compatibility of Materials

4.5.1 Design Precautions

All equipment shall be designed to suppress corrosion in an exposed environment with special reference to galvanic corrosion.

The Contractor shall ensure that dissimilar metals or alloys alongside each other are compatible or are adequately protected if, in the galvanic series, there is more than a 0,3 volt difference in the galvanic potential.

4.5.2 Galvanic Corrosion Prevention

The Contractor shall ensure that the following steps are taken to minimise corrosion:

(a) If dissimilar metals are used: Coat all surfaces of the whole assembly including the more noble member of the galvanic series.

(b) If the noble member of the assembly cannot be entirely covered:

  (i) Keep the anode/cathode ratio as large as possible in the particular component.

  (ii) Use electrical insulators between two metals. Insulation must be complete, a bolt requires a sleeve as well as washers of an insulating material.

(c) Joints and crevices between metals shall be sealed.

(d) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

4.6 Handling of Clean Items

After cleaning, surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces shall be clean and free from oil, grease, grit, dirt and other contamination.

4.7 Machined and Matching Surfaces

Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating or lining shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

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4.8 Special Areas

Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coats shall be fully cured before assembly.

Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating and/or lining application and installation.

Friction grip areas shall be left un-coated unless otherwise specified.

4.9 Supports

During coating and/or lining application, the items shall be so supported to prevent damage to the wet coatings or linings until the coatings or linings have hardened adequately. Items shall remain supported during curing, storing and handling.

4.10 Water Retention Areas

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible.

Surfaces of corrodible metals, such as the insides of tanks or hollow Specifications that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

4.11 Stripe Coats and Crevices

All complex surfaces including metal edges, up stands, welds, bolts and nuts shall be adequately coated to ensure complete corrosion protection. Additional stripe coats shall be applied after initial priming, if required or ordered by the Engineer.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

4.12 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and repairs will be subject to inspections as set out in Clause 11.2. Where the damage is extensive the particular remedial procedures for each such instance shall be agreed with the Engineer in writing.

All repairs shall comply with the requirements of the repair-product Manufacturer's Instructions. The Engineer may at his discretion request that repaired areas undergo adhesion tests.

Any damage occurring during transit from the Contractor's premises to the Site shall be the responsibility of the Contractor. The Contractor shall repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Sub-Clauses 5.4 and 5.9 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or

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other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of this Specification.

Paint surfaces which become streaky because paint has run, will be rejected.

Touching up of damage to the final paint coat will NOT be permitted. If final paint coat is damaged the item shall completely repainted with the finishing coat in accordance with the specifications.

4.12.1 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Thoroughly abrade the area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.
- Vacuum-clean the surface to remove dust and debris in accordance with Clause 7.2to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to achieve the specified electrical insulation thickness and finish as to conform to the adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

4.12.2 Repair Methods for Major Defects

The repair of areas showing damage down to the steel surface shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Blast-clean area to Sa 3 (ISO 8501-1).
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.
- Vacuum-clean the surface to remove dust and debris in accordance with Clause to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to conform to the specified adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

4.13 Quality Control

This clause and its sub-clauses shall be read in conjunction with the project's quality control plan, if any.

4.13.1 Submission for Approval

The Contractor shall submit the following to the Engineer, including data sheets where applicable, for approval:

4.13.1.1 Corrosion Protection

- A programme;
- The Quality Control Plan (QCP) for corrosion protection indicating hold points;

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- Process Method Statement;
- Blast material;
- Proposed corrosion protection systems; and
- Proposed pickling and passivating products.

4.13.1.2 Manufacture and Corrosion Protection Programmes

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted:

- Inspection of material;
- Hydrostatic testing of uncoated castings, pipes and fittings;
- Manufacture of components;
- Fettling or dressing;
- Degreasing;
- Water soluble salts test;
- Blast cleaning and application of the first coat;
- Application of intermediate and final coats; and
- The commencement of Site repairs.

4.14 Health & Safety Requirements

4.14.1 Control of Major Classes of Risk

(a) Health risks, these include:

(i) Gases/vapours;

(ii) Volatile liquids in the paint; and

(iii) Powders/dust.

(b) Fire or explosion risks, these include:

(i) Fire risk during storage/transport; and

(ii) Explosion hazard during application.

4.14.2 General Aspects of Explosion Hazards

The essential precaution to be taken is, inter alia that sufficient ventilation air shall be provided to maintain the ratio of vapour/air to no more than 10% of the lower explosive limit.

4.14.3 General Aspects of Toxic Hazard

Measures shall be taken by the Contractor to ensure that the following are prevented:

- Inhalation of dust/fumes;
- Skin contact with paint;
- Ingestion of paint; and
- Eye contact/penetration of paint.

Operators shall be provided with the necessary Personal Protective Equipment (PPE), such as masks/hoods, barrier creams and protective clothing to minimize the chances of the above occurring.

Emergency procedure shall be in place and First Aid kit provided to deal adequately with any of the above occurrences.

The Contractor shall ensure that in terms of Clause 6(2) of the Construction Regulations of the OH&S Act 85 of 1993, an assistant construction supervisor is specifically appointed for the application or

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repairs of linings inside enclosed or semi-enclosed areas e.g. pipe linings, prior to the execution of any such work.

4.15 Specific Requirements for Pipes and Specials

4.15.1 Cut Back of Coated Pipes

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface. Cut-backs shall comply with the requirements as set out in Table 4-1 below:

Table 4-1: Cut-back of Coatings

PIPE END	CUT-BACK (mm)	COMMENT
Pipe ends prepared for field butt welding	100	All coatings to be mitred or feathered to prevent air entrapment in the joint coating system
Pipe ends prepared for flexible joint couplings	Various	The coating shall be cut back a sufficient distance to accommodate a standard coupling for the particular diameter of pipe
"Bell and spigot" pipe ends prepared for first welding	100	The cut back shall be measured from either side of the (field) external fillet weld position when the spigot is fully inserted into the "bell"

4.15.1.1 Protection of Pipe Ends on Pipes with Cut-Back

Before delivery cut backs of each pipe for field welds shall be coated with an approved rust inhibitor. This inhibitor shall provide corrosion protection for up to 6 months and shall enable good cutting and welding properties (Sigmaweld 120, Plascon etching primer or equivalent approved). Plain ended pipes (to be joined by flexible couplings) are to be coated with an approved rust inhibitor for a distance of 100mm from the pipe ends on the inside and the outside of each pipe. Careful attention must be paid to ensuring the pipe ends are also completely covered. The inhibitor used must be compatible with both the lining and the coating.

4.15.2 Pipe Ends

4.15.2.1 Extension of Lining

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for Site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap surfaces on the outside by at least 25 mm.

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4.15.2.2 Butt Weld Edges

For pipes and specials intended for Site butt-welding, lining and coating shall extend up to a distance of 50 mm from pipe ends. The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and Site with a coat of weldable primer (of a different colour to the lining/coating).

4.15.3 Field Joints

No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, unless otherwise approved by the Engineer in writing.

The materials used for the repairs to field joints, linings and coatings shall be the same as that used for the pipes, unless otherwise approved by the Engineer in writing.

The linings and coatings of butt welded steel pipes or continuously welded steel cylinder type prestressed concrete pipes, shall be made continuous over joints as soon as possible after approval and acceptance by the Engineer of the welded joint. At no time shall field joints, lining and coating repairs/remedial work lag more than 250 metres behind the last pipe laid.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

4.15.4 Supports

When pipes are installed or mounted on concrete supports, rubber insertion shall be used to insulate the pipe from the support. The thickness of the rubber insertion shall not be less than 10 mm and protrude not less than 20 mm all round.

4.15.5 Sealing

Pipes that enter or exit concrete shall be sealed on their circumference with a continuous polyurethane or polysulphide flexible sealer, in a 25 mm square recess.

4.15.6 Spare Pipes

Corrosion protection of spare pipes shall where applicable be supplied with a top coat of Re-coatable Polyurethane to a DFT of 30 – 50 µm, colour white or silver, for storage and above ground installation.

5 Materials

The material requirements for each corrosion protections system is specified in the relevant clauses of Clause 10 and shall be read in conjunction with this clause.

5.1 General

All materials in a corrosion protection system shall be purchased from the same manufacturer unless approved by the Engineer.

Materials offered and subsequently approved shall not be changed without written approval of the Engineer.

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All corrosion protection materials shall be delivered in the manufacturer's original containers clearly marked with the following:

- Manufacturer's name;
- Product Brand and Reference Number;
- Batch Number which may incorporate the date of manufacture;
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application; and
- The SANS mark where applicable.

Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication.

5.2 Toxicity of Lining Material

Materials used for the lining of equipment that will be in contact with water shall be non-toxic and shall not impart any odour, taste, or colour to the water.

5.3 Storage

All corrosion protection materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

6 Contractor's Equipment

6.1 Handling and Transportation

The plant and equipment used by the Contractor for handling of pipes, valves, pumps and other equipment, for the purpose of corrosion protection shall be such that no pipe shell, valve or pump casing or any other piece of equipment is over stressed during any operations covered by this Specification.

6.2 Surface Preparation Equipment

The Contractor shall provide all the equipment required for abrasive blast cleaning, preparation and cleaning of all surfaces to be coated.

6.3 Compressor

Compressors used for abrasive blast cleaning shall be fitted with an after cooler and oil and water traps such that the air delivered at the nozzle is completely free from oil and water. The volume displacement of the compressors shall be adequate for the number and bore of blast nozzles, the spray equipment and flame spray equipment that may be necessary to carry out the specified coating operations.

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6.4 Application Equipment

The Contractor shall provide all the equipment required for airless spray painting, two component hot airless spray painting, electrostatic powder coating, fluidised bed powder coating, or any other approved method of applying the corrosion protection system in the shop or required for site application and repairs to coats. All equipment shall be thoroughly cleaned on completion of each day's work and maintained in clean working order.

6.5 Inspection of Equipment

All facilities and equipment shall be subject to inspection by the Engineer or the independent inspectorate and defects in the equipment shall be rectified when so required.

6.6 Inspection Equipment

The Contractor shall supply all facilities and equipment for inspecting and testing the specified preparation and corrosion protection of all items supplied under the Contract. Recent calibration certificates shall be available for all equipment requiring calibration. This equipment shall be made available to the Engineer or his independent inspectorate for the purpose of testing the specified corrosion protection systems and verifying the accuracy of the test equipment.

7 PREPARATION OF SURFACES TO BE COATED

The surfaces of all items to be coated and/or lined, irrespective of the corrosion protection system used, shall be prepared in accordance with the relevant following requirements.

7.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1344	Medium duty solvent detergent.
SANS 10064	The preparation of steel surfaces for coating.
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method).
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
SANS 5770	Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts).
SANS 5772	Profile of blast-cleaned steel surfaces for painting (profile gauge).
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.

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ISO 11127 Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.

7.2 Surface Condition

Before surface preparation all items to receive a coating or lining shall be in rust condition A to C of ISO 8501-1. Items in rust condition D will be rejected.

Prepared surfaces shall conform to Table 7-1 below. If only surface cleanliness to ISO 8501-1 is specified in the Specifications then the corresponding values of Table 7-1 for degreasing, surface profile and soluble salts shall apply.

Table 7-1: Surface Condition

Cleanliness to ISO 8501-1 (min)	Sa 3	Sa 2½	St 2
Residual dust quantity rating and size class (ISO 8502-3)	1 / 0	1 / 1	1 / 1
Oil, grease and perspiration	Nil	Nil	Nil
Surface Profile(min) Layers up to 200 µm (max)	30 µm 50 µm	30 µm 50 µm	n/a
Surface Profile (min) Layers > 200 and up to 300 µm (max)	50 µm 80 µm	50 µm 80 µm	n/a
Surface Profile (min) Layers > 300 and up to 500 µm (max)	60 µm 100 µm	60 µm 100 µm	n/a
Water soluble salts: Maximum at any point. Average of any 250 cm of Pipe length.	 100 mg/m² 100 mg/m²	 400 mg/m² 100 mg/m²	 500 mg/m² 100 mg/m²

Note: The maximum surface profile shall be less than ⅓ of the coat thickness.

Unless otherwise specified in the Amendments to this Specifications the surface condition shall conform to the following requirements:

- Sa 3 for the environmental condition classified as severely corrosive,
- St 2 for Tape Wrapping, and
- for all other environmental conditions the surface condition shall be Sa 2½.

7.3 Preparation of Items

Prior to the application of any coat, each item shall comply with the following:

- Weld splatter shall have been removed by chipping or grinding to a smooth surface flush with the surrounding steel.
- Weld seams shall have a smooth contour, free from sharp edges, protrusions and undercuts.
- Sharp edges and protrusions shall have been removed by grinding to a smooth radius. The radius shall be a minimum of 3 mm for steel of thickness 6 mm or greater, or a minimum of 50% of the steel thickness for steel of thickness less than 6 mm.

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- Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 3.5% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the Engineer.
- Articles for hot-dip galvanizing shall not have any overlapping joints. Closed sections shall be suitably vented.

7.4 Cleaning of Items

7.4.1 Degreasing

All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

In the event that degreasing is required, items shall be degreased by the use of a water based solvent degreaser such as that complying with SANS 1344 or, for use in enclosed systems, with SANS 1365.

Items shall be thoroughly washed with clean potable water to remove all residues. The items shall then be allowed to dry. The washed surfaces shall be tested after degreasing to show that no oil, grease and chemical contamination are present.

Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

7.4.2 Blast Cleaning

Blast-cleaning shall be done in accordance with the code of practice SANS 10064. Any abrasive used for blast cleaning shall composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

The surface of the items to be coated or lined shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following requirements:

- The surface condition shall be in accordance with ISO 8501-1 as stipulated in Clause 4.2 and specified in the Amendments and Additions of the Specification, when tested in accordance with SANS 5772.
- Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the above requirements. If grinding penetrates the steel to a depth greater than 3.5% of the nominal wall thickness, the item will be rejected.
- The time interval between abrasive blast cleaning and paint application shall not exceed those given in Clause 9.2.6.2.

7.4.3 Mechanical Surface Preparation

Cleaning by hand or by means of power tools (e.g. wire brushing) shall be carried out in accordance with the methods described in SANS 10064 to the standards specified in the Amendments of this Specifications and as shown in ISO 8501-1 and Clause 7.2.

7.5 Pickling and Passivation

Where specified the following areas shall be pickled and passivated:

- All un-coated areas;
- Ground and sheared edges; and
- Heat affected zones caused by welding or cutting.

Where possible, pickling and passivation shall be done by the dipping process.

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Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Pickling formulations made up of 15 to 20% nitric acid (HNO3) and 1 to 2% hydrofluoric acid (HF) by volume with potable water are considered suitable. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Repeat the process, if necessary to remove all discolouration. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

8 Surface Preparation Methods

The requirements as specified below shall be read in conjunction with the requirements of Clause 7 Preparation of Surfaces to be Coated. Each preparation method specified below shall also conform to the relevant requirements of Clause 7 and its sub-clauses. Where in in conflict with Clause 7 and its sub-clauses the requirements hereunder shall take precedence.

Unless otherwise specified in the Amendments of this Specifications and subject to the approval of the Engineer, the surfaces of all items to be coated and/or lined shall be prepared in accordance with one or more of the following methods.

8.1 Mild Steel

Components manufactured from mild steel shall be degreased and blast clean before the corrosion protection system is applied. Oil and grease contamination, when present, shall be removed to a water break free surface by degreasing (Refer to Clause 7.4.1) before blast cleaning (refer to Clause 7.4.2).

Steel items less than 2 mm thick may distort when blast cleaned. Sheet steel items less than 2 mm in thickness shall be degreased, acid pickled and phosphated with an approved proprietary 7 or 9 stage process to produce a fine grain zinc phosphate surface complying with SANS 10064 Table 1 Lightweight or by a proprietary process approved by the Engineer for the standard of cleaning specified.

All surfaces of steel 2 mm or more in thickness shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 and cleaned to achieve the requirements given in Table 4-1 for the standard of abrasive blast cleaning specified.

8.2 Cast Iron and Cast Alloys

Cast iron shall be abrasive blast cleaned until all sand particles, residual burnt-on sand and casting skin have been completely removed. Cast iron surfaces shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 to achieve the requirements given in Clause 7.2 for the standard of abrasive blast cleaning specified.

Blowholes and omegas in cast surfaces shall be opened up where necessary and filled with a two component solvent free epoxy filler. When the filler has set hard, the surface shall be abraded to be flush with the surrounding metal.

8.3 Stainless and Corrosion-Resistant Steel

Components manufactured from stainless or corrosion-resistant steel shall be supplied in the fully passivated condition. Sheared edges, welds or surfaces subjected to any form of heat treatment or contamination with iron or mild steel, shall be pickled and passivated in terms of Clause 7.5.

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Surfaces shall thereafter be thoroughly degreased in terms of Clause 7.4.1, then rinsed with potable water to obtain a water-break-free surface.

When it is required to paint stainless steel exceeding 2 mm thickness, the surface shall be blast cleaned in accordance with the parameters given in Clause 7.2, using non-metallic abrasives such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast-iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by the use of non-metallic abrasive pads, followed by washing with clean potable water to a water-break-free surface. If a water-break-free surface is not obtained, detergent cleaning shall be repeated until the surface is water-break-free. Allow the surface to dry before coating.

8.4 Aluminium

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water-break-free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometres dry film thickness) of wash primer, mixed and applied in accordance with the manufacturer's instructions. Note that the "wash primer" is an adhesion promoter and does not replace the primer specified in the paint system.

8.5 Hot-Dip Galvanized Surfaces

Hot-dip galvanized surfaces shall be thoroughly degreased by scrubbing with water rinsable solvent degreaser, followed by thorough washing with clean, potable water. If the water breaks up into islands of non-wetted surface, the degreasing shall be repeated until a water break free surface is obtained. Small areas may be abraded with a non-metallic abrasive paper prior to painting. Large surfaces may be sweep blast cleaned, using ultra-fine abrasive (particle size 0,2 to 0,8 mm) and a nozzle pressure not exceeding 300 kPa. A uniform matt surface shall be obtained. Loss of zinc thickness shall not exceed 10 µm. Cracking and flaking of the galvanized layer is indicative of excessive blast cleaning by using too coarse abrasive or too high blast pressure. Such surfaces will be rejected. The article shall then be stripped and re-galvanized.

8.6 Painted Surfaces

8.6.1 Primer Only

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

The succeeding coats shall be compatible with the primer. Where the type of primer is unknown, a test patch shall be applied. There shall be not loss of adhesion or other defects of the primer or between primer and undercoat. If defects or adhesion loss occur, the primer shall be completely removed, feather blasted and replaced by a primer which is compatible with the specified system.

8.6.2 Recoatable Materials

Surfaces painted with recoatable paints shall be abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried to remove dust and deposits before overcoating.

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8.6.3 Fully Cured Non-Recoatable Materials

Surfaces painted with fully cured non-recoatable paints that have exceeded their overcoating time shall be thoroughly abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried before overcoating. The edges of any damage shall be smoothly feathered into the sound paint. Repairs to damaged areas shall extend 25 mm beyond the damage.

8.6.4 Two Component Paints within their Overcoating Time

Surfaces painted with two component paints where the paint is still within the overcoating time specified by the manufacturer shall be recoated without special surface preparation. Where the surface has become contaminated, it shall be cleaned.

8.7 Plastic Surfaces Such as PVC and GRP

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

8.8 Concrete and Plaster Surfaces

Concrete and plaster surfaces to be painted shall be clean, dry and free from laitance, dust or similar friable surface layers and from mould oil or similar contaminants that will interfere with the adhesion of the coating or lining.

Mould oil shall be removed by the use of a water-based detergent followed by high pressure water washing. When all contaminants have been removed, the surface shall be allowed to dry either to a damp condition or to a completely dry condition, depending on the coating or lining to be applied.

For immersion or other heavy duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

Off shutter concrete usually shows surface blowholes or omegas. Omegas shall be drilled or chipped open to the full hole diameter. Blowholes and opened omegas shall be filled with a suitable filler such as acrylic or solvent-free epoxy. The use of gypsum or cellulose-based fillers is not permitted for underwater or humid conditions. Shutter kicks and similar projections shall be removed by grinding to a smooth surface.

For coatings or linings of low water permeability, such as solvent-borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth of not less than 5 mm.

The first coat of the coating or lining system may require thinning with the manufacturer's recommended solvent to assist in penetration of the substrate.

9 Application of Corrosion Protection System

All coatings and/or linings, irrespective of the surface preparation method or corrosion protection system used, shall be applied in accordance with the relevant following requirements.

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9.1 Conditions During Application

If in the opinion of the Engineer adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective system, he shall order a stoppage of work. The Contractor will be deemed to have accepted this risk and made provision for it in his rates.

9.1.1 Dusty Conditions

Coats shall not be applied in dusty or contaminated conditions.

9.1.2 Surface Temperature

Coats shall not be applied if the surface temperature of the base metal is less than 3°C above dew point or outside the range 5 - 40°C, unless otherwise recommended in the manufacturer's instructions.

9.1.3 Ambient Temperature

Coats shall not be applied when the ambient temperature is less than the minimum or greater than the maximum recommended by the manufacturer's instructions of the corrosion protection material.

9.1.4 Relative Humidity and Time Interval

The time interval between abrasive blast cleaning and paint application shall not exceed those given in Table 9-1.

Table 9-1: Maximum time interval - Between blast cleaning and coating

Ambient Relative Humidity	Maximum Time (hours)
Below 50%	6
50% - 70%	4
70% - 85%	2
Over 85%	Coating not permitted - Reblast and coat when rel. humidity below 85%

Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining/coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish.

9.2 Paints

9.2.1 Application Method

The recommendations of the paint manufacturer as per the manufacturer's instruction (refer to Clause 4.2) as shown on his data sheets or given in writing shall be followed.

Apart from touch up, all liquid paints applied in the shop shall be applied by means of airless spray machines. Before use all paints shall be thoroughly stirred so as to be completely homogeneous. Two component paints shall be thoroughly mixed in the correct proportions as specified in the manufacturer's data sheet.

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Painting on site shall be carried out to the Engineer's written approval. Significant surfaces to be painted on site shall be those specified in the Specification or shown on the drawings. Site application methods shall comply with the paint manufacturer's recommendations.

9.2.2 Colour

Successive coats shall have distinctively different shades to facilitate coverage of each coat. Unless otherwise specified in the Amendments to this Specification, or directed by the Engineer, the final paint colour shall be that given in Appendix B of this specification and shall be a commercial match to the appropriate colour in SANS 1091 - National Colour Standards for Paint.

9.2.3 Wet Film Thickness

The Contractor shall regularly and frequently monitor wet film thickness and shall calculate the dry film thickness from the volume solids of the paint.

9.2.4 Mixing

All paint components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

9.2.5 Degree of Cure

The degree of cure of paint will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

9.2.6 Overcoating

9.2.6.1 Compatibility of Coats

All primer, intermediate, finishing coats and layers shall be mutually compatible and recoatable paints shall be used where applicable. There shall be not loss of adhesion between the consecutive coats or other defects.

9.2.6.2 Overcoating intervals

The minimum and maximum overcoating intervals provided in the manufacturer's data instructions shall be strictly observed. Times and dates of application shall be recorded for each separate item and coat in the quality control records.

Since overcoating times are frequently quoted at 20 °C or 25 °C, longer overcoating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5° decrease (or by 100% for a 10° decrease) in the ambient temperature below the temperature quoted in the data sheet.

9.2.6.3 Thickness of Consecutive Coats

Generally a corrosion protection system will be build-up with multiple coats. The thickness of all coats, primer, intermediate or finish coats shall be strictly according to the manufacturer's instructions. For solvent-base paints it is imperative that the applicator does not exceed the maximum film thickness per coat applied in order to prevent entrapment of the solvent and the formation of pinholes.

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9.3 Duplex or Multi-Layer Systems

Duplex or Multi-layer systems consist of more than one corrosion protection system applied consecutively e.g. a Hot-Dip Galvanizing and Polyurethane system

The specifications for each of the corrosion protection systems shall be strictly followed. Special attention shall be given to adhesion between the systems.

9.4 Finishing on Site

Repairs, finish painting and cleaning on the site are regarded as inherent parts of the installation. On completion of erection, all pipework, control gear and indicating gear shall be thoroughly cleaned.

After erection, paint work shall be washed down, using nylon brushes and detergent to remove all adhering contamination. It shall then be washed with clean water to remove all traces of detergent and allowed to dry. The finishing coat shall then be applied as specified in the Amendments to this Specification.

All surfaces which cannot be painted after erection shall be painted as specified before erection. The painting system so applied shall be allowed to become fully hard dry (for at least two weeks for epoxy type paints) before erection.

For coatings such as epoxies, having a limited overcoating interval as specified in the manufacturer's data sheets, the surface shall be washed and thoroughly abraded to a matt finish before application of the finishing coats in accordance with the manufacturer's instructions.

9.5 Tolerances

9.5.1 Individual Coats Film Thickness

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no reading shall be less than 70% of the specified minimum thickness.

9.5.2 Total Dry Film Thickness

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For severely corrosive conditions no reading shall exceed the specified thickness by greater than 60% of the minimum.

10 Corrosion Protection Systems

The requirements as specified below shall be read in conjunction with the requirements of Clause 9: Application of Corrosion Protection Systems. Each system specified below shall also conform to the relevant requirements of Clause 9 and its sub-clauses. Where the requirements of this clause is in conflict with Clause 9 and its sub-clauses the requirements hereunder shall take precedence.

10.1 Recommended Corrosion Protection System

Unless otherwise specified in the Amendments to this Specification and subject to the approval by the Engineer, Plant, equipment and pipework in pump stations and water and wastewater treatment works

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and pipelines shall be corrosion protected with one or more of the corrosion protection systems described in the following paragraphs of this Specification.

10.2 System 1: Alkyd Resin Based

Alkyd systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection. Defects such as runs, sags, curtaining, shrivelling or wrinkling will not be permitted.

10.2.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 630: Decorative high gloss enamel paints.

SANS 681: Undercoats for paints

SANS 1319: Zinc phosphate primer for steel

10.2.2 Material

Alkyd zinc phosphate primer for steel shall comply with the requirements of SANS 1319.

General purpose alkyd undercoat shall comply with the requirements of SANS 681 Type 2.

Alkyd enamel shall comply with the requirements of SANS 630.

10.2.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7-1and the applicable Method as specified in Clause Surface Preparation Methods8.

10.2.4 Application

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments to this Specification.

10.2.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in Clause 4.12.

10.2.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.3 System 2: Vinyl Resin Based

Vinyl copolymer (PVC) paints are a single component vinyl resin-based paints have excellent resistance to water, chemicals, dilute acids and hypochlorites. Their resistance to heat is poor and they must never be used on surfaces continually subjected to a temperature of 70 °C or higher. They

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are not resistant to solvents and should not be used where there may be contact with oils, grease, kerosene, petrol etc.

The main advantage of vinyls is their easy maintainability. Whereas epoxies are difficult to recoat after about one month's exposure, vinyls may be recoated after any period of time.

Vinyls are recommended for use above water and for interior and exterior use where and could be subject to chemical fumes, as in chlorination rooms.

10.3.1 Material

Vinyl copolymer (PVC) paints shall have a solids content of 50% by mass and 32% by volume with a viscosity of 4,5 poise +_ 0,5 poise. The paint shall be stabilised against UV radiation.

10.3.2 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1.

10.3.3 Application

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments to this Specification.

10.3.4 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in Clause 4.5.

10.3.5 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.4 System 3: Thermal Spray Metal

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

10.4.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 2063: Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys

10.4.2 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table Table 7-1.

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10.4.3 Application

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

The minimum coating thickness for both aluminium and zinc shall be 150 µm. Greater thicknesses may be specified for particular applications.

Thermal spray metal paints shall be continuously agitated in a pressure pot to ensure dispersion of the zinc particles in the liquid components.

The time between surface preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

10.4.4 Repair of Damaged Coats

The requirements of Clause 10 shall apply.

10.4.5 Testing

The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles. Angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes. The minus tolerance on thickness in isolated areas shall also not exceed –10 % and such low areas shall not be larger than 50 mm in diameter.

10.5 System 4: Powder Coats

10.5.1 Standards

Reference is made to the latest issues of the following Standards:

BS 5493: Protective coating of iron and steel structures against corrosion.

10.5.2 Material

Material used shall conform to SANS 1217, Type 2, powder coating.

10.5.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Clause 7.2 and Table Table 4-1.

10.5.4 Application

10.5.4.1 Coating Thicknesses

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments to this Specification.

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10.5.4.2 Coating Application

Powder shall be applied in the shop by electrostatic spray or by fluidised bed as applicable. Items for powder coating shall after surface preparation, be pre heated to the required temperature, usually in the range 200 to 250 °C, coated by electrostatic spray or by fluidised bed, then post cured if necessary to obtain complete fusion and cure. For surfaces to be immersed the applied coating shall be tested for defects by high voltage spark testing. No defects will be permitted. Thermoset materials such as FBE shall be fully cured.

10.5.5 Repair of Damaged Coats

No repairs of damaged coatings will be accepted.

10.5.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.6 System 5: Two Pack Epoxy

This corrosion protection system is suitable for large steel items subject to medium corrosive and severely corrosive environmental conditions such as valves, pipes, etc.

10.6.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

ISO 2808: Paints and varnishes - Determination of film thickness.

BS 5493: Protective coating of iron and steel structures against corrosion.

10.6.2 Material

The material used for two component (two pack) high build polyamide epoxies shall be based on epoxy-polyamide resins and shall comply with the requirements of SABS 1217. Epoxies shall be of the high build, modified aluminium epoxy mastic type, containing at least 90% solids.

Solvent free epoxies in accordance with SANS 1217 Type 1B is preferred. Type 1A (solvent-borne chemically cured paint material) will only be approved by the Engineer for specific application conditions.

The epoxies shall be non toxic and non tainting when it will be in contact with potable water.

10.6.3 Surface Preparation

Unless otherwise specified in the Amendments to this Specification the surface preparation shall confirm to the requirements Clause 7.2.

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10.6.4 Application

10.6.4.1 Dry Film Thicknesses

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments to this Specification.

10.6.4.2 Mixing

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed.

The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. For two pack materials, the use of part of the contents (split packs) is strictly forbidden.

In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

During application, paint materials shall be agitated regularly to keep the solids in suspension.

The preparation time, induction time and pot life of these materials shall be closely adhered to.

10.6.4.3 Curing

Adequate ventilation (and heating if required), shall be provided for the proper curing of the epoxy coating or lining in all circumstances with special reference remedial work, repairs and to field joints of pipelines.

10.6.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in terms of Clause 4.12**Error! Reference source not found.**.

10.6.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.6.7 Pipe Field Joints for Epoxy Linings

The internal corrosion protection System of welded field joints, for pipes with epoxy linings, shall be the same as that used for the adjacent pipes.

The surface preparation of the field joint area shall be the same as for the repair of major defects as specified in Clause 4.12.

10.7 System 6: Fusion Bonded Epoxy (Heavy Duty)

This corrosion protection system is suitable for large steel items subject to medium corrosive and severly corrosive environmental conditions such as valves, pipes, etc.

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10.7.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

ISO 12944: Paints and varnishes – Corrosion protection of steel structures by protective paint systems.

10.7.2 Material

Material used shall conform to SANS 1217, Type 2, powder coating.

10.7.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

10.7.4 Application

10.7.4.1 Dry Film Thicknesses

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments to this Specification.

10.7.4.2 Coat Application

Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

The normal procedures pertaining to powder application shall apply.

On completion of the coating or lining, items shall be cured for 60 minutes at 200°C (mean temperature).

10.7.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12. with an approved repair kit.

10.7.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.8 System 7: Hot-Dip Galvanizing (Heavy Duty)

This corrosion protection system is suitable for steel items subject to mildly corrosive and medium corrosive environmental conditions such as handrails, covers, small diameter pipework, etc.

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[redacted]

10.8.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 32: *See EN 10240.*

SANS 121: Hot-dip galvanized coatings on fabricated iron and steel articles.

SANS 1344: Medium duty solvent detergent.

SANS 2063: Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys.

SANS 5772: Profile of blast-cleaned steel surfaces for painting.

ISO 752: Zinc ingots.

ISO 2808: Paints and varnishes - Determination of film thickness.

ISO 14713: Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines.

EN 1179: Zinc and zinc alloys – primary zinc.

EN 10240: Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

10.8.2 Material

Impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1.5%.

Steel to be hot-dip galvanized shall be as listed below. In both cases material certification shall be supplied:

- For aesthetic appearance:
  - Aluminium killed steel, or
  - Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.
- For general corrosion protection:
  - Aluminium killed steel, or
  - Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

The condition of articles to be hot-dip galvanized shall comply with Clause 7.3 of SANS 121.

The condition of tubes to be hot-dip galvanized on a continuous line shall comply with "Annexure A" of EN 10240.

10.8.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements of Clause 7.2.

10.8.4 Application

Galvanizing shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SANS 121 and EN 10240.

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The coating of lining thickness shall comply with the values specified for General Applications or Heavy Duty Applications as specified in this Specification.

Galvanized surfaces which are to be painted shall NOT be passivated by the galvanizer.

10.8.5 Special Requirements

10.8.5.1 Steel Specials

10.8.5.1.1 Surface

Surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash will not be permitted.

Notwithstanding Clause 6.1 of SANS 121, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Double dipping shall not be allowed.

10.8.5.1.2 Thickness

The thickness of hot-dip galvanizing shall comply with the requirements of the Table 10-1 below.

Table 10-1: System 7 - Minimum Coat Thickness on Items that are not Centrifuged

ARTICLES AND ITS THICKNESS	HEAVY DUTY	LIGHT DUTY	
	Thickness µm (min)	Local Thickness µm (min)	Mean Thickness µm (min)
Steel ≥ 6 mm	105	70	85
3.0 mm ≤ Steel < 6.0 mm	80	55	70
1.5 mm ≤ Steel < 3.0 mm	65	45	55
Steel < 1.5 mm	55	35	45
Castings ≥ 6.0 mm	105	70	80
Castings < 6.0 mm	-	60	70

Heavy duty coats are required except in the following cases:

- Where a high surface finish is required; and
- Where otherwise specified in the Amendments to this Specification.

10.8.5.2 Steel Tubes

Steel tubes shall be in accordance with Clause 7 of EN 10240.

10.8.5.2.1 Surface

The surface of the coat shall be continuous, smooth and free from flux residues.

10.8.5.2.2 Thickness

The thickness shall comply with the requirements of the coat quality A1, in accordance with Clause 8, Table 1 of EN 10240, as specified below.

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Table 10-2: System 7 - Minimum Local Coat Thickness Requirements for Coat Quality A1

REQUIREMENTS	QUALITY A1
Minimum local coat thickness on the inside surface except at the weld bead	55 µm
Minimum local coat thickness on the inside surface at the weld bead	28 µm
Minimum local coat thickness on the outside surface	55 µm

- Adhesion

The coat shall show no evidence of flaking or cracking when tested in accordance with Clause 11.4 of EN 10240.

- Qualities

Coat qualities shall be A1 for water installations – see Sub-Clause 8.2 of EN 10240. The surface of the coat on the inside shall be as smooth as can be achieved by steam blowing.

10.8.6 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

10.8.6.1 Steel Items

10.8.6.1.1 Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

10.8.6.1.2 Thickness

Thicknesses shall be in accordance with Clause 10.8.5 and shall be tested in accordance with Sub-Clause 6.2 of SANS 121.

10.8.6.2 Steel Tubes

10.8.6.2.1 Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

10.8.6.2.2 Thickness

Shall be tested in accordance with Sub-Clause 11.3 of EN 10240 (SANS 32).

10.8.6.2.3 Adhesion

Shall be tested in accordance with Sub-Clause 11.4 of EN 10240 (SANS 32).

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10.8.6.3 Chemical Analysis

Items shall be tested in accordance with Sub-Clause 11.5 of EN 10240 (SANS 32).

10.8.7 Repair of Damaged Coats

10.8.7.1 General

Repairs to damaged galvanizing shall be carried out in accordance with the procedures specified in SANS 121 by hot metallic zinc spraying unless the use of an appropriate solder is approved. Conventional solder shall NOT be used. Solder composition shall have been approved in writing by the SANS (Metallurgy Division) or by the SAHDGA.

10.8.7.2 Steel Items

The total un-coated areas for renovation by the galvanizer shall not exceed 0.5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm². If un-coated areas are larger, the item containing such areas shall be re-galvanized.

The repair method shall be approved by the Engineer before repairs are initiated.

Repairs shall be by zinc thermal spray in accordance with SANS 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer to Clause 7.

The coat thickness on the renovated areas shall be a minimum of 30 µm more than the local coat thickness specified in Clause 10.8.510.8.5 for the relevant hot-dip galvanized coat unless otherwise specified by the Engineer. The coat on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

10.8.7.3 Steel Tubes

Repairs shall not be allowed on internal surfaces of tubes. Where repairs are required, tubes shall be re-galvanized. Repairs on external surfaces shall be in accordance with Clause 10.8.7.1.

10.9 System 8: Elastoplastic Polyurethane

This part of the Specification applies to two component solvent free elastoplastic polyurethane. This system shall only be used in limited approved applications.

10.9.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

10.9.2 Material

The paint material shall be a solvent free two-component polyurethane hybrid based on a polyester type polyol and aromatic isocyanate. The cured paint shall comply with the following requirements:

- Tensile strength at 3 mm thickness - ASTM D638 - not less than 15 MPa.
- Adhesion to primed steel - SANS Method 776 - not less than 10 MPa.

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- Impact resistance (direct) - ASTM G14 - not less than 9 Joules.
- Dielectric Strength - not less than 10 kV/mm.
- Elongation at break - not less than 25%.
- Compressibility - not less than 25 MPa.
- Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'.
- Water Vapour Permeability - not greater than 0.5 g/24 h/m²/mm².
- Cathodic disbonding - when tested in accordance with ASTM G8 Method A, for 60 days, the disbonded area shall not exceed 500 mm².

10.9.2.1 Adhesive

Adhesive shall be a two component polyurethane adhesive designed to maximise adhesion between used polyurethane and freshly mixed polyurethane.

10.9.3 Application

10.9.3.1 Dry Film Thicknesses

Dry film thicknesses shall be at least as follows unless otherwise specified in the Amendments to this Specification:

- Overcoating as duplex system:
  - The dry film thickness shall be 40 µm minimum.
- For corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 1.0 mm minimum.
- For highly corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 3.0 mm minimum.

10.9.4 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12

10.9.5 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.10 System 9: Tape Wrapping

The tape wrapping system is intended to be used in areas where special protection is required due to handling of items e.g. pipelines at road crossings etc. or where it is highly likely that the paint system can be damaged e.g. at specials and addition precaution is required to protect the pipeline. It is also often used to repair field joints of pipelines. It is suitable for severely corrosive environments.

10.10.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1117: Plastic wrappings for the protection of steel pipelines.

SANS 10129: Plastics tape wrapping of steel pipelines.

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[redacted]

10.10.2 Material

Polyethylene pressure-sensitive tape or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SANS 1117, types A, B or C.

10.10.3 Application

10.10.3.1 General

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SANS 10129 as amended and supplemented by this Specification. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

10.10.3.2 Surface Preparation

Steel pipe surface preparation shall conform to Clause 3.2 of SANS 10129.

10.10.3.3 Priming

Immediately after surface preparation but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust, a primer shall be applied according to Clause 4.2.1 of SANS 10129.

10.10.3.4 Normal Wrapping

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50 mm on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with Clause 4.2.3 of SANS 10129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer Clause 10.10.6

10.10.3.5 Armouring

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

- All road crossings through sleeves and culverts;

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- All railway crossings through sleeves or culverts; and
- Wherever the Engineer may consider that special conditions warrant such measures.

10.10.3.6 Wrapping of Specials

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by bitumen-fibre glass or epoxy corrosion protection system in accordance with the requirements of the applicable corrosion protection system. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

10.10.3.7 Armour Wrapping of Coated Pipes

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50% shall be applied.

10.10.4 Tolerances

10.10.4.1 Pressure Sensitive Tape Wrapping

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300 µm and the maximum thickness of the outer high-density tape carrier shall be 1000 µm. Total minimum polyethylene thickness of 1450 µm.

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

10.10.4.2 Butyl Rubber Laminates

The minimum thickness of the completed wrapping shall be 750 µm. The inner layer shall be a butyl rubber laminate of 450 µm minimum thickness of which the butyl rubber film shall not be less than 200 µm thick and the polyethylene film shall not be less than 200 µm thick.

The outer layer shall be high density pressure tape of 300 µm minimum thickness.

10.10.5 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

10.10.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

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10.10.5.2 Non-Destructive Testing

10.10.5.2.1 Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested to ASTM G62 with an approved Holiday Detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved Holiday Detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no Holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a Holiday Detector with a copper bristle brush detector.

10.10.5.2.2 Insulation Test

The Engineer shall carry out a conductance test on the wrapping over any section of pipeline between valves when the pipeline has been wrapped and installed in the trench with padding and back filling completed. The test shall be conducted as per NACE TM0102 with the valves temporarily removed from the line, at the Contractor's expense, to ensure complete isolation of the pipeline section under test or between gaps left for tie-ins.

The length of the section of pipeline under test shall be carefully measured and the conductance over the section tested shall not exceed 180 micro-Siemens per square metre of pipe surface under all conditions of test. If the results of the test for the section of pipeline tested are not satisfactory, two sections immediately adjacent to the testing section will be tested. If the results on one or both of these sections tested are not satisfactory, all sections of wrapped pipeline shall be tested.

10.10.5.3 Destructive Testing

The Engineer may from time to time collect samples of 10 m of each type of tape and one litre of primer for testing, for compliance with the Specification, by any independent laboratory appointed by the Engineer. The supply of samples shall be for the Contractor's account. The Engineer reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

10.10.5.4 Repair of Damaged Coats

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

10.10.6 Repair Methods

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

10.10.6.1 Small Damaged Areas

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

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Clean and prime the exposed area in accordance with Clauses 10.10.3.2 and 10.10.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

10.10.6.2 Large Damaged Areas

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely removed from the pipe over the affected section. The area shall be cleaned and primed in accordance with Clauses 10.10.3.2 and 10.10.3.3. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

10.10.6.3 Damage on Double Wrap

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small Holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in Clauses 10.10.610.10.6 shall be used to affect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with Clause 10.10.3.5.

10.10.6.4 Outer Wrap Damage

Where damage extends through an outer wrap / rockshield (see Section 6 of SANS 10129), this shall be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping.

The repair shall be carried out by the appropriate method given in Clauses 10.10.6 and the outer wrap/rockshield re-instated in accordance with Clause 10.10.3.5.

10.11 System 10: Petrolatum Wrapping

Profiling mastic and mastic blankets are used for corrosion protection of couplings and flanges in chambers with high humidity and buried in soil.

Standards

Reference is made to the latest issues of the following Standards:

ISO 8501-1: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.

SANS 10129: Plastics tape wrapping of steel pipelines.

10.11.1 Surface Preparation

Mechanically clean and wire brush the joint to remove all loose rust, scale, old coating or lining and foreign matter to St 2 (ISO 8501-1).

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[redacted]

Areas subjected to chemical attack, salt spray, fungus or bacteria shall be neutralized, rinsed with clean potable water and mechanically cleaned as specified above.

10.11.2 Priming

Brush priming solution well over the entire joint area, leaving a thin film (at a nominal coverage rate of 0.8 m²/litre). Apply a liberal amount around the bolt threads, narrow cavities and crevices.

Paste shall be used where excessive surface corrosion has occurred and under high humidity or submerged conditions.

10.11.3 Application

Use profiling mastic and/or strips to fill all voids, crevices and sharp or irregular contours.

Apply mastic tape circumferentially over the area to be coated with a 25 mm overlap on either side of the mastic with a 75 mm end overlap.

Pre-formed petrolatum mastic blanket system (10 mm thick), supported by a coated tape backing, is available to provide a quick and easy method to apply this system.

Eliminate all air pockets, wrinkles and creases.

10.11.4 Top Coat

10.11.4.1 Buried Conditions

Two complete turns of the polyethylene sheeting shall be applied circumferentially. The ends are secured to the pipe barrels with 48 mm wide bands of PVC adhesive tape, which is also applied to the outside diameter of the bolted joint.

10.11.4.2 High Humidity Conditions

Overcoat with a synthetic coat mixed with a cementitious filler to give a tough, flexible coat. The base coat may be over-coated with water based Acrylics or Epoxies.

NOTE:

- Detail of application shall be in accordance with the manufacturer's data sheets and approved by the Engineer.

10.12 System PC1: Solvent Free Polyurethane Coating

This corrosion protection system covers the application of Solvent Free Polyurethane as a coating to steel pipes. Generally the coating is to be applied in accordance with ANSI/AWWA C222-99 'Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings'. Where in conflict with ANSI/AWWA C222-99, the amendments hereunder shall take precedence.

10.12.1 Section Numbers of ANSI/AWWA C222-99

The section (clause) and sub-section numbers in this clause refer to the same numbered sections and subsections in ANSI/AWWA C222-99.

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10.12.1.1 ANSI Section 4.2 Test Requirements

Replace 'Table 1 Requirements' with the new Table 1 below.

New Table 1: Physical and Performance Requirements

Property	Polyurethane Coating Material	Test Method Sub-Section
Adhesion, MPa min (laboratory)	15 MPa	ASTM D 4541
Impact resistance Kg m, min	1.6 kg m	ASTM D 2794 Intrusion
Water absorption %, max	max 3%	ASTM D 570 long term
Dielectric strength kV/mm thick min	7.5 kV/mm thick min	SANS 1217 clause 5.9
Resistance to abrasion, mg max	max 100/1000 rev	ASTM D 4090 CS17 1 kg 1000 cycles
Cathodic disbondment	max 12 mm radius	ASTM G 95 at 23 deg C
Durometer Hardness	min 65 Shore D	ASTM D2240
Chemical Resistance		ASTM D543
10% sulphuric acid	max 5% in mass, length or width	
30% NaCl	max 5% in mass, length or width	
30% NaOH	max 5% in mass, length or width	
Diesel fuel	max 5% in mass, length or width	

10.12.1.2 ANSI Section 4.3 Coating Thickness

ANSI Sub-Section 4.3.1

The minimum dry film thickness of coating is to be 2000 microns within a tolerance of -100 microns and +1000 microns.

10.12.1.3 ANSI Section 4.4 Surface Preparation

The requirements of section 4.4 of ANSI/AWWA C222-99 will apply and will take precedence over Clause 3.2 above.

10.12.1.4 ANSI Section 4.7 Welded Field Joints

ANSI Sub-Section 4.7

The hold backs (cut-backs) are to comply with Clause 4.15.1 of this Specification.

10.12.1.5 ANSI Section 5.3 Coating Tests

ANSI Sub-Section 5.3.1

The basis of acceptance of proposed coating material shall be as per method (1).

10.12.1.6 ANSI Section 5.5 Coated Pipe Inspection

ANSI Sub-Section 5.5.4

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Electrical continuity inspection shall be conducted on all pipes as per Clause 5.9 'Dielectric strength' of SABS 1217.

10.12.1.7 ANSI Sub-Section 5.5.3

The adhesion is to be tested in accordance with ANSI/ASTM D4541.

10.12.1.8 ANSI Section 6.5 Affidavit of Compliance

The manufacturer is to submit with his/her first request for payment an affidavit that all material and work has been conducted in accordance with the requirements of this standard.

10.13 System PC2: Fusion-Bonded Medium Density Polyethylene

This coating system shall comply with the Australian Standard Specification AS 4321-1955 entitled "Fusion bonded medium density polyethylene coating and lining for pipes and fittings" except as modified hereunder.

10.13.1 Modifications to Specification AS 4321-1955

10.13.1.1 Preparation of Surface

Delete Clause 5.1 of AS 4321-1955 and replace with Section 3 "SURFACE PREPARATION FOR PIPES TO BE COATED AND LINED" of this specification.

10.13.1.2 Repairs

Delete the last sentence of Clause 8.1 of AS4321-1995 and replace with "Damaged areas that pass the continuity test need not be repaired provided that the coating or lining thickness is equal to or greater than the thickness specified in Table 1 of AS 4321-1995. Generally no more than 3 repairs will be allowed per 9m length of pipe and the area of a single repair is not to exceed 0.01 square m. If the area of a single repair does exceed 0.01 square m the pipe will be rejected. Repairs may be undertaken in accordance with Clause 8 of AS 4321 for the following methods of repair:- Fusion bond; Heat shrink sleeve or Hot gas welding. A wrapping system may also be used if applied as detailed hereunder.

10.13.1.2.1 Repairs with Tape

When repairs are permissible the repairs shall be made using a repair system comprising (1) a polymer bitumen primer (Denso Primer D or equivalent approved), (2) an inner seal of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) and (3) an outer protective layer of acrylic coated/modified bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. The outer protective tape is to be wrapped around the entire pipe.

10.13.1.2.1.1 Pinholes

At each pinhole detected by the electrical test, the surrounding area shall be abraded to at least a minimum area of 175mm by 175mm around the hole. The abrasion shall be carried out (with clean

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emery paper of 80 to 100 mesh) around the repair so as to provide a suitable rough surface profile without causing the removal or excessive amounts of coating material. The repair area is to be feathered into the surrounding sound coating. Debris and other deleterious matter are to be removed by means of a clean rag moistened with Cleaning Solvent. The primer is applied and once it has dried the prepared surface is covered with a patch of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) of size 150mm by 150mm. The bond is to be free of air bubbles and smoothed out by hand or using an aluminium fluted roller. Finally, acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape.

10.13.1.2.2 Larger Damaged Areas

The edges of the damaged coating must be chamfered back to remove all potential void areas. The primer and modified bitumen rubber are applied as for pinholes but the modified bitumen rubber tape is pre-cut and applied with 55% overlap Finally acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. Weld beads are repaired with suitable lengths of the above size tapes. When covering weld beads, the centre portion of the square must make contact first. Smooth the tape out with an outward direction to remove all entrapped air.

10.13.1.3 Storage, Handling, Transport and Marking

Add to Clause 11 of AS 4321-1955, Clause 1.5 entitled "Plant and Rigging for the handling and delivery of Pipe and Specials" of this specification.

10.14 System PC3: Three Layer System

The three layer corrosion protection system consists of a powdered epoxy primer, a polymeric adhesive and a polyethylene outer sheath which shall be applied in accordance with Canadian Standards Association Specification (CSA) Z245.20-06 and Z245.21-06.

The application is to be in accordance with, inter alia, the following sections of the Canadian specifications listed below.

10.14.1 Z245.20 External Fusion Bond Epoxy Coating for Steel Pipe

(a) General Requirements

(b) Materials

(i) The following Fusion Bonded Epoxy primers are approved for use.

(a) Akzo Nobel PCL 331

(ii) Jotun CORRO-COAT EP-F 1003HW

Should the Supplier wish to use any other make of primer, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

(c) Coating Application

(d) Inspection and Testing

(e) Repair of Coated Pipes

(f) Markings

(g) Handling and Storage

(h) Test Reports and Certificates of Compliance

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[redacted]

(i) Test Procedures

10.14.2 Z245.21 External Polyethylene Coating for Pipe

(a) General Requirements

The Polyethylene outer sheath is to comply with System B1

(b) Materials

(i) The following adhesives are approved for use:-

(a) Borealis Borcoat ME0420

(b) Industrie Polieco M.P.B. SRL COESIVE L8.92.8

(ii) The following HDPE Outer Sheath materials are approved for use:-

(a) Borealis Borcoat HE3450

(b) Industrie Polieco M.P.B. SRL HDPE 2050

Should the Supplier wish to use any other make of adhesive or outer sheath materials, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

(c) Coating Application

(d) Inspection and Testing

(e) Repair of Coated Pipes

(f) Markings

(g) Handling and Storage

(h) Test Reports and Certificates of Compliance

(i) Test Procedure

10.15 System PC4: Bitumen Fibre Coating

10.15.1 General

Where bitumen fibre coating of steel pipes is specified, the method of coating is generally to comply with SABS 1178 'The production of lined and coated steel pipes using bitumen or coal tar enamel'. The lining is to consist of a hot-applied bitumen with a double wrap of glass fibre reinforcing material to a thickness of 5mm. There shall not be less than 1mm of bitumen between the pipe surface and the inner wrapping and also between the inner and outer wrappings. Where in conflict with SABS 1178, the amendments hereunder shall take precedence.

10.15.2 Amendments to SABS 1178

The following details are to be noted. The clause and sub-clause numbers hereunder refer to the same numbered clauses and sub-clauses in SABS 1178.

10.15.2.1 SANS Sub-Clause 3.1.1 Primers

Before the application of external protections, pipes and specials shall be primed with primer type (a) a cold applied bitumen primer complying with SABS 1136 or a synthetic primer for bitumen, complying with SABS 1140.

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[redacted]

10.15.2.2 SANS Sub-Clause 3.1.2.1 Bitumen

The bitumen used is to conform to SABS 1137.

10.15.2.3 SANS Sub-Clause 3.1.3 Reinforcement Wrappings

Glass fibre material is to be used as the reinforcement wrapping and is to conform to SANS 1130.

10.15.2.4 SANS Sub-Clause 3.1.4 Reflective Finish

A non-stick, reflective covering shall be applied to the coating. This shall consist of a lime wash based on a dolomitic type lime suitable for non-porous surfaces mixed with water to a slurry and further mixed with boiled linseed oil to improve its water resistance.

10.15.2.5 SANS Sub-Clause 3.2.2 Coating and Table 1

The coating type is to be CB6A as per Table 1. However, the inner wrap may conform to type 1 or type 3 of SABS 1130 and the outer wrap may conform to type 1, type 2 or type 3 glass fibre reinforcing material. The minimum coating thickness excluding the weld seam is to be 5mm. The thickness tolerance shall be +2mm,-0mm.

10.15.2.6 SANS Sub-Clause 3.7.7 Disbonded Areas

Holidays are not to be repaired unless authority to do so is given by the Engineer.

10.15.2.7 SANS Sub-Clause 3.7.8 Holidays

The coating shall be free from holidays and tested in accordance with Clause 7.2.2 of SABS 1178 at 15 Kv.

10.15.2.8 SANS Clause 6 Markings

Refer to Clause 7 of Sub-Clause 2.2 of this specification.

10.15.2.9 SANS Sub-Clause 7.1 Inspection

Add the following sentence:

Before leaving the shop the coating of every pipe and special shall be inspected visually for all defects including, but not restricted to:- tears, holes, mechanical damage and cracking.

10.15.2.10 SANS Sub-Clause 7.2.2 Holiday Detection

A metallic brush or a jointed spiral ring type of scanning electrode is to be used on the variable voltage detector.

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10.15.2.11 SANS Sub-Clause 7.3 Destructive Tests

Sufficient coating material shall be removed from the ends of at least one pipe of each day's production for the purpose of carrying out destructive tests as detailed under Clause 7.3 of SABS 1178.

10.16 System PC5: Polymer Modified Bitumen Coating

This corrosion protection system is suitable for large pipes items subject to medium corrosive and severely corrosive environmental conditions.

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen.

10.16.1 Standards

This standard makes reference to the documents listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

British Standards

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints:
	Part A 6 (replaced by EN 535) – Determination of flow time of paints.
	Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.
BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.

Swedish Standard

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.

American Standard

ASTM D 113-86Ductility of bituminous materials.

ANSII AWWA C203-91 Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

South African Standard

SANS Method 772	Blast profile.

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10.16.2 Materials

10.16.2.1 Primer

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen. The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in Table 10-3:. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in Table 3 for not less than 6 months from the date of delivery.

Table 10-3: Characteristics of Primer

CHARACTERISTIC	REQUIREMENTS	METHOD OF TEST
Viscosity at 23°C	35-60 seconds	Flow cup No 4
		BS3900: Part A6 = EN 535
Volatile matter	75	BS3900: Part B2 = ISO/DR
(max. % loss by mass)		1515 (105^{0}C for 3 hours)

10.16.2.2 Polymer Modified Bitumen

10.16.2.2.1 Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

10.16.2.2.2 Filler Grading

Method of test to BS 1796 modified to use the metric sieves specified in BS 410.

Passing 90 microns – not less than 93%.

Passing 250 microns – not less than 99%.

10.16.2.2.3 Characteristics of the Polymer Modified Bitumen

The material shall conform to the requirements given in Table 4 when tested in accordance with the methods specified.

10.16.2.2.4 Performance Tests of the Polymer Modified Bitumen System

The polymer modified bitumen shall be of thermoplastic rubber/bitumen modification.

The polymer modified bitumen containing mineral filler with the characteristics detailed in 10.16.5.1.2 shall pass the performance test specified in Table 10-4.

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Table 10-4: Characteristics and Performance Test for Polymer Modified Bitumen

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Softening Point	ASTM D36	°C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm^3	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm^2	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

NOTES:

- The test plates shall be cleaned by abrasive blasting to grade Sa 2½ of SIS OS 5900 (BS 7079 and ISO 8501 – 8504) and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m^2.
- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbanded shall not exceed the permitted value shown in Table 4.
- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

10.16.2.3 Outerwrap

(a) The outerwrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outerwrap to provide maximum protection.

(b) The outerwrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in Table 10-5.

(c) The characteristics of the outerwrap shall comply with the requirements of Table 10-5 and shall be determined in accordance with the test procedure.

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Table 10-5: Characteristics of Outerwrap Saturant

CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

Table 10-6: Physical Characteristics of Outerwrap

CHARACTERISTIC	TYPE A	TYPE B	METHOD OF TEST
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m^2	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

10.16.3 Application

10.16.3.1 Care of Wrapping Materials

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

10.16.3.2 Care of Pipe

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

10.16.3.3 Marking

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

10.16.3.4 Blast Cleaning

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to at least Sa 2½ grade SIS 05 009 (BS 7079 and ISO 8501-8504) SANS 772 and surface profile amplitude 75 µm. DWS 9900 C1 for detailed description of surface preparation process.

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10.16.3.5 Priming

(d) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.

(e) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.

(f) The primer should be applied at a pipe temperature of 10°C (or above) or 3°C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.

(g) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

10.16.3.6 External Coating and Wrapping Application

(h) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outerwrap.

(i) All primed surfaces shall be clean and dust free immediately prior to coating.

(j) The coating shall have an average thickness of not less than 4 mm, with an absolute minimum thickness of 3 mm. The coating shall be reinforced by a spirally-wound layer of outerwrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outerwrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.

(k) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.

(l) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of ±5 mm, unless otherwise specified by the Employer or his representative.

(m) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

10.16.4 Inspection and Testing

The Contractor shall be responsible for, and shall bear the cost of a system of inspection and repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

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[redacted]

(n) Monitoring of grit size and the finish of blast cleaned pipe.

(o) Viscosity measurement (see Table 3) and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.

(p) Adequate temperature control the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified in Table 4, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in Table 10-7.

(q) Visual checks on the outer wrap and the appearance of the final wrap.

(r) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.

(s) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.

(t) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m^2 of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a signification number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

Table 10-7: 'In Plant Testing'

TEST		FREQUENCY OF TESTING
1.	Softening Point	Twice per working shift
2.	Penetration at 25°C	Twice per working shift
3.	Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Approved Inspection Authority (AIA), who would be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.

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When tested, the wrapping shall not be disbanded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

10.16.5 Methods of Testing

10.16.5.1 Testing of Wrap Characteristics

10.16.5.1.1 General

The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

10.16.5.1.2 Thickness

The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m^2 and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

10.16.5.1.3 Weight per m^2

The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of ± 2%.

10.16.5.1.4 Tensile Strength

The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width. (See Table 4 for the minimum tensile strength).

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

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10.16.5.2 Bond Test for Coated Pipes

(u) Measure the temperature of the coating with a surface thermometer.

(v) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.

(w) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.

(x) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.

(y) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.

(z) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

10.16.6 Handling

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

10.16.7 Repairs

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

10.17 System PL1: Cement Mortar Lining

This corrosion protection system covers the application of Cement Mortar as a steel pipe lining. The pipes will be used to convey potable water.

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10.17.1 Standards

Reference is made to the latest issues of the following Standards:

AS 1281-2001: Cement mortar lining of steel pipes and fittings

10.17.2 Material

All materials for the cement mortar lining of pipes shall be in accordance with AS 1281-2001.

10.17.3 Application

10.17.3.1 Mixing of Mortar

Components of the mix shall be accurately weighed. Each batch shall be identical. Mixing shall be carried out in a suitable mechanical mixer. Aggregate and cement shall be measured in correct proportions, then dry mixed in the mixer. When homogeneous, water shall be added from a measuring vessel to achieve the correct consistency but shall not exceed the amount stated previously. When correctly mixed, the material shall be used as soon as possible and not later than 1 hour after the first addition of water. Re tempering of the mix by further addition of water or other material shall not be permitted.

From a random batch of each days production prepare three 150 mm test cubes, in accordance with SANS 5863. After 28 days curing, the compressive strength shall not be less than 30 MPa.

10.17.3.2 Placing of Cement Mortar

Cement mortar shall be placed to the specified thickness by spin casting (preferred method) or by mechanical drag trowel. In either case, sufficient centrifugal force shall be used to ensure optimum bonding to the pipe wall and optimum compaction of the cement mortar, with minimum segregation of different sizes of aggregate. The finished lining shall be smooth and uniform. Hand application is not permitted except on specials or by prior agreement of the Engineer.

10.17.3.3 Curing of Lining

After completion of placing, spinning, trowelling an end finish, the lining shall not be disturbed until set. The pipe ends shall be closed with waterproof end covers or caps and the pipe shall be left undisturbed for at least 40 hours. After 48 hours the lining shall be sprayed with a fine mist of water and the covers and caps replaced or shall be steam cured by an approved method. The lining shall be kept wet for not less than 7 days. Pipes shall not be transported within 21 days from the date of applying the lining.

During placing of the cement mortar and the whole of the curing period, the pipes shall be kept constantly in the shade or under cover. Pipes shall not be exposed to direct sunlight.

Some of the pipes are likely to be stored on site for periods in excess of 3 months before being laid.

10.17.4 Testing

The Quality Control Plan and Procedure referred to in Clause 4.13 above will detail the means of demonstrating compliance with AS 1281-2001 and will be based on Appendix B of AS 1281-2001.

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10.18 System PL2: Solvent-Free Epoxy Lining

This system is specific design to be used as a lining system for pipelines conveying potable water and raw water.

10.18.1 General

This corrosion protection system covers the application of Solvent Free Liquid-epoxy as a steel pipe lining. Generally the lining is to be applied in accordance with AWWA C210-97 'Liquid-epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines'. Where in conflict with ANSI/AWWA C210-97, the amendments hereunder shall take precedence. The full cost of all the testing is to be included in the rates for coating unless it is itemised separately in the Schedule of Quantities.

10.18.2 Amendments to AWWA C210-97

The section and sub-section numbers in this clause refer to the same section and sub-section numbers in AWWA C210-97.

10.18.2.1 AWWA C210 Section 1.1 Scope

ANSI Sub-Section 1.1.2 Coating and Lining Systems

The lining system is to be type (3), a single coat of a two part, chemically cured epoxy coating. In the event of the thickness being less than the minimum specified the coating shall be removed and the pipe length shall be re-blasted and re-lined to comply with the specification.

10.18.2.2 AWWA C210 Section 4.2 Quality and Safety

Details of all quality related controls and tests are to be included in the QCP&P referred to in Clause 4.13 of the Employer's specification above.

AWWA C210 Sub-Section 4.2.2 Certification

Copies of the certification of the products used, as required by this section, are to be submitted with the tender documents.

10.18.2.3 AWWA C210 Section 4.3 Coating Systems

AWWA C210 Sub-Section 4.3.1 Liquid-Epoxy Coatings.

Add the following:-

The following products have been approved, or equivalent, shall be used: - Sigma Line 523, Carboline 891 and Denso ST100. Should the Manufacturer/ Supplier wish to offer an alternative product it will be necessary to get the approval of the Engineer. Only solvent free epoxies which have been certified nontoxic and non-tainting and suitable for use with potable water will be permitted. Any delays in approval will not be accepted as a reason for late delivery.

AWWA C210 Sub-Section 4.3.2 Coating Thickness

The pipes shall be lined to a dry film thickness of a minimum of 406 and a maximum of 1000 microns, and shall be free from sags and runs.

AWWA C210 Sub-Section 4.3.4 Physical Requirements

Replace Table 1 with the following new Table 1

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Tests 1 through 3 in the new TABLE 1 new shall be conducted on every pipe.

Tests 4 and 5(a) and 5(b) in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production or from each new batch of liquid epoxy, whichever is more frequent.

Tests 6, 7 and 8 in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production of each item.

Should the Manufacturer experience difficulties in achieving this specification, additional tests may be required by the Purchaser until the problem(s) has been identified and rectified. Such additional tests shall be to the Purchaser's account.

NEW TABLE 1

No	PROPERTY	REQUIREMENT	TEST METHOD
1	Visual	Smooth glossy or semi-glossy finish, free from excessive runs, sags, orange peel, occlusions or other visible defects	Use an experienced observer
2	Coating Thickness	Min 406 microns Max 600 microns	ISO 2808. Take a minimum of 2 readings per m^2 of surface up to 300 mm nominal bore, or 12 per m^2 over 300 mm
3	Electrical Insulation Defects	Nil defects at 90 Volts, 10 Mega-ohm	SABS 1217, Section 5.10
4	Impact Resistance	No defect at 1 Joules	SABS 1217, Section 5.6 but modified as given in Note 1
5a	Degree of cure: • Static Test	No softening or discolouration when fully cured	SABS 1217, Section 5.8. Cure time shall be in accordance with the manufacturer's data
5b	• Dynamic Test	No softening or discolouration when fully cured	50 Double rubs with cotton wool swab soaked in MEK. Cure time shall be in accordance with the manufacturer's data
6	Adhesion (Hot water soak)	Not more than 15 mm disbonding from point of V	Immerse in water at 75°C for 48 hrs. Make V cut at 30° angle. Test adhesion when panel has cooled to 25°C
7	Cathodic Disbonding	Total disbonded area not to exceed 40 mm diameter after 30 days. Current flow not to exceed 5mA	ASTM G8 Method B – Magnesium Anode - 20°C – 7 mm holiday
8	Cathodic Disbonding	Total disbonded area (including holiday) not to exceed 20 mm diameter	Impressed current -3, 5 volts potential at 75°C for 48 hours 3 mm artificial holiday

NOTE: Impact resistance shall be carried out on a sample of production pipe firmly clamped and choked (to be rebound free) to a rigid base. No electrical insulation defects shall be detected at the point of impact when tested at 1 Joule.

10.18.2.4 AWWA C210 Section 4.4 Coating Application

AWWA C210 Sub-Section 4.4.1 General

Application by airless spray is required.

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AWWA C210 Sub-Section 4.4.2 Pipe Preparation

The requirements of section 4.4.2 of AWWA C210-97 will apply and will take precedence over the Purchaser's Clause 3.2 above.

AWWA C210 Sub-Section 4.4.3.2 Hold-Back for Field Welds

The hold backs (cut backs) are to comply with the Clause 4.15.1 of this Specification.

AWWA C210 Sub-Section 4.4.3.4 Application Temperature

Add the following:-

The cure rate of liquid epoxy coating is very dependent upon temperature, with the rate of cure being very slow below 10°C and the reaction generally ceasing below 5°C. Manufacturer's tendering for this type of lining are therefore expected to have a heated shop or warm air blowers with suitable heat insulating tunnels to enable the temperature of the coating to be maintained at not less than 15°C from the time of application until full cure has taken place. Adverse weather conditions will not be accepted as a reason for delay in supply.

10.18.2.5 ANSI Section 4.5 Coating Repair

AWWA C210 Sub-Section 4.5.1 Defective Coating

Add the following at the beginning of the Clause:

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 3 per pipe. A cluster of pinholes within a radius of 25mm shall be regarded as one defect. Any pipe needing repairs in excess of this number or where the lining shows any sign of flaking or loss of adhesion shall not be repaired. The lining shall be removed and the pipe length shall be re-blasted, cleaned and re-coated to comply with the requirements of the specification.

AWWA C210 Sub-Section 4.5.1.1

Delete this sub-section and replace with the following:-

Repairs with Epoxy

When repairs with epoxy are permissible, the following method shall be used :-

- Abrade an area at least 25mm diameter around and beyond the defective area. The abrasive paper shall not be coarser than 220 mesh and shall be preferably 400 mesh. It shall be used preferably wet to avoid excessive removal of coating.
- The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating. After abrasion, the area shall be wiped clean with M.E.K. or other suitable approved clean solvent and allowed to dry.
- All repairs shall be undertaken using a repair product recommended by the material manufacturer.
- Repair material shall be mixed in the proportions supplied by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self metering packs.
- The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2mm of the edge of the abraded area. A "halo" of abraded area shall be visible around the repair material.
- After curing, the repair and at least 250mm surrounding area shall be tested for electrical insulation defects as specified in the contract. There shall be no electrical insulation defects.

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11 Compliance with Requirements

11.1 Testing

Tests, instruments, methods and criteria shall be as specified below or in the Amendments of this Specification.

The requirements of Clauses 4.13 shall apply.

11.1.1 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

11.1.2 Holiday Inspection

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

Except on system containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

For systems exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217.

During the inspection procedure the Contractor shall ensure that sufficient moisture is present at all times on the surfaces to be tested.

11.1.3 Dry Film Thickness

The dry film thickness (DFT) shall also conform to the requirements of Clause 9.5

(a) Measurements shall be taken in accordance with ISO 2808.

(b) 100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

(c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the system is demonstrated to be sound in all respects.

(d) The method used to measure film thickness, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

11.1.4 Degree of Cure of Fusion-Bonded Materials

The degree of cure of corrosion protection material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

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11.1.5 Free of Oil and Grease

11.1.5.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the "water-break-free" method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

11.1.5.2 Solvent-Wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

11.1.6 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SANS 5770 or by means of the Weber Reilly Test.

11.1.7 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in SABS ISO 8501-1.

11.1.8 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with SANS 5772.

11.1.9 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with ISO 8502-3.

11.1.10 Blasting Material

All blasting-materials shall be approved by the Engineer.

11.1.10.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

11.1.10.2 Non-Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

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11.2 Pipe and Specials Specific Testing

11.2.1 Dry Film Thickness (DFT)

Measurements shall be taken in accordance with ISO 2808.

100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Engineer, and may be dictated by accessibility.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

DFT shall be tested within 7 days of application.

The method used to measure DFT, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the coating work.

11.2.1.1 Automated Shop Applied Lining and Coating

The film thickness on the first pipe of a production run and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Engineer may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the coats.

11.2.1.2 Hand and In-situ Applied Lining and Coating

All the hand applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

12 Measurement and Payment

12.1 General

The rates tendered under this Specification shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the Items provided in Specification.

Payment for the requirements of this Specification will be included in the payment item for the particular item supplied including painting or corrosion protection. No separate payment shall be made for painting and corrosion protection unless specifically allowed for in the Bill of Quantities.

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12.2 Scheduled Items

12.2.1 QCP and documentation Unit: lump sum (Sum)

Separate Items are provided in the Bill of Quantities for the submission of the Quality Control Plan (QCP) and all other pre-manufacture documentation.

The rate shall include full compensation for the preparation and submission of the QCP and the submission of all pre-manufacture documentation in compliance with the Specification.

Payment will only be made after the QCP and all documentation has been approved by the Engineer."

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ANNEXURE A: Applicable Standards

The following Standards and Codes of Practice are referred to in this Specification:

Standards Australia

AS 1281-2001	Cement mortar lining of steel pipes and fittings
AS 4321-2001	Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings

American National Standards Institute

ANSI B31.3	Standards of pressure piping

American Petroleum Institute

API 5L	Specification for line pipe
API 1104	Standard for welding pipelines and related facilities

American Society of Mechanical Engineers

ASME BPVC-IX	Boiler and Pressure Vessel Code – Section IX, Welding and Brazing Qualifications

American Society for Testing of Materials

ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A312	Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

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ASTM D4090	
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM G8	Standard Test Methods for Cathodic Disbonding of Pipeline Coatings
ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM G62	Standard Test Methods for Holiday Detection in Pipeline Coatings
ASTM G95	Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

American Water Works Association

AWWA M11	Steel pipe – A guide for design and installation (3rd edition)
AWWA: C207 - 1994	Steel pipe flanges 4" through 144".
AWWA: C208 - 1996	Dimensions for fabricated steel water pipe fittings.
AWWA C210-97	Liquid epoxy coating systems for the interior and exterior of steel water pipelines
AWWA C222-99	Polyurethane coatings for the interior & exterior of steel water pipe & fittings

British Standards Institution

BS 970	Specification for wrought steels
BS 2494	Materials for elastomeric joint rings for pipe work and pipelines
BS 2633	Class I arc welding of ferritic steel pipe work for carrying fluids

Canadian Standards Association

CSA Z245.20	External Fusion Bond Epoxy Coating for Steel Pipe
CSA Z245.21	External Polyethylene Coating for Pipe

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European Standards

EN 1179	Zinc and zinc alloys – Primary zinc
EN 10240	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

International Organization for Standards

ISO 544	Welding consumables - Technical delivery conditions for welding filler materials - Type of product, dimensions, tolerances and markings
ISO 752	Zinc ingots
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO 11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.

NACE International

NACE TM0102	Measurement of Protective Coating Electrical Conductance on Underground Pipelines

South African Bureau of Standards

SANS 32	*See EN 10240*
SANS 62-1	Steel pipes Part 1

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SANS 121 (ISO 1461)	Hot-dip galvanised coatings on fabricated iron and steel articles
SANS 630	Decorative high gloss enamel paints
SANS 681	Undercoats for paints
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 1091	National colour standard
SANS 1117	Plastics wrappings for the protection of steel pipelines
SANS 1130	Fibre reinforcing material for pipe wrapping
SANS 1178	The production of lined and coated steel pipes using bitumen or coal tar enamel
SANS 1200 L	Standardized specification for civil engineering construction Section L: Medium-pressure pipe lines
SANS 1217	Internal and external organic coating protection for buried steel pipelines
SANS 1274	Coatings applied by the powder-coating process
SANS 1319	Zinc phosphate primer for steel
SANS 1344	Medium duty solvent detergent
SANS 1365	Solvent degreasers that contain chlorinated hydrocarbons
SANS 1700	Fastners
SANS 2063	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys
SANS 5770	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Freedom from certain soluble salts
SANS 5772	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by a micrometre profile gauge
SANS 10044	Welding
SANS 10064	The preparation of steel surfaces for coating
SANS 10120-3 HC	Code of practice for use with standardized specifications for civil engineering construction and contract documents Part 3: Guidance for design Section HC: Corrosion protection of structural steelwork

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SANS 10129	Plastics tape wrapping of steel pipelines
SANS ISO 14713	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines

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ANNEXURE B: Paint Colour Coding

MECHANICAL AND GENERAL

ITEMS	COLOUR	SANS 1091 CODE
Structural steel, Gates	Light grey	G29
Hydraulic power Pack	Strong blue	F11
Hydraulic oil	Salmon pink	A40
Hazardous objects/areas (restricted headroom, crane hook etc.)	Golden yellow with black chevron	B49*
Handwheels and levers	Golden yellow	B49
Handrails: vertical - horizontal	Black Golden yellow	 G49
Handrails on dam walls - Aluminium - Stainless steel - Galvanized	Un-coated Un-coated Light grey	 G29
Floors: - safe and walking areas - restricted areas - open flooring (gratings) – MS galvanized 3Cr12 Stainless steel	 Emerald green Golden yellow Un-coated Un-coated Un-coated	E14 B49*
Fire protection Plant	Signal red	A11*
Control panels	Eau de nil	H43

PUMP STATION

ITEMS	COLOUR	SANS 1091 CODE
Electric motors	Light beige	C57
Pumps/control valves: for raw water for chem-treated water	Apple green Middle blue	H29 F07
Fan and coupling guards	Signal red	A11*
Base plates	Black	
Overhead traveling cranes	Golden yellow	B49
Isolating valves: for raw water for chem-treated water	Brilliant green Arctic blue	H10 F28

ELECTRICAL

ITEMS	COLOUR	SANS 1091 CODE
Low voltage panels: Indoor Outdoor	Light orange Light orange	B26* B26
Medium voltage panels: Indoor Outdoor	Admiral grey Admiral grey	G12 G12

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ITEMS	COLOUR	SANS 1091 CODE
Panel accessories (gland plates, back plates, interior)	White	
UPS Plant items	Light orange	B26
Transformers	Light stone	C37
LV distribution kiosks, mini subs	Light stone	C37
Standby electrical Plant items(Permanently powered)	Signal red	A11*
General outdoor	Light grey green	H40
All Plant– interior	White	

WATER TREATMENT PLANT

ITEMS	COLOUR	SANS 1091 CODE
Plant	Same colour of respective pipe work	
Handwheels (remote valves)	Same colour of respective pipe work	
PIPE WORK		
Raw water	Brilliant green	H10
Chemical treated raw water	Verdigris green	E22
Clarified raw water	Eau de nil	H43
Filtered water	Pale blue	E39
Chlorinated filtered water	Arctic blue	F28
Backwash water	Cornflower blue	F29
Air saturated water	Turquoise blue	E18
Wash water recovery	Middle buff	B33

SEWAGE PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Raw sewage	Dark earth	B11
Settled sewage effluent	Brilliant green	H10
Biologically treated sewage effluent	Verdigris green	E22
Final/chlorinated effluent	Eau de nil	H43
Digested sewage sludge	Middle brown	B07
Raw sewage sludge	Dark brown	B03
Humus sludge	Golden brown	B13
Return activated sludge	Golden brown	B13
Waste activated sludge	Middle brown	B15
Supernatants/underflows returning to head of works	Middle buff	B33

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DOSING/CONTROL PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Poly-electrolyte	Pinotage	A08
Alum/Ferric chloride	Jacaranda	F18
Chlorine solution	Primrose	C67
Chlorine gas	Lemon	C54
Chlorine liquid	Light orange	B26
Lime slurry	Biscuit	B64
Lime hydrated	Biscuit	B64
Lime saturated water	Biscuit	B64
Air/compressed air	White	
Steam	Pastel grey	G54

NOTE: Colours marked thus * are restricted for specified Plant only.

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General specification

Design and Manufacture of Medium Pressure Steel Specials
Specification number: SPE-MP-7001

Document control					
Specification no.		SPE-MP-7001			
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Signature					

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1 Scope

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel specials of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L, when included in the Contract. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments to this Specification.

2 Normative References

2.1 Supporting Specifications

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract:

(a) Amendments;

(b) SANS 1200 Series of Standardized Specifications;

(c) SANS 1200 L: Medium-pressure pipelines (see Clause 1 above)

(d) Specification SPE-MP-7002 : Manufacture of Medium Steel Pipes

(e) Specification SPE-JJ-0003 : General Corrosion Protection

(f) Specification SPE-CC-7003 : Laying and Jointing of Medium Pressure Steel Pipes and Specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the design and manufacture of welded steel specials manufactured using approved welding techniques.

3 Definitions and Abbreviations

3.1 Definitions

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply.

Cut-and-shut bend — A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)

Fitting

a) A special or valve.

b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.

Flexible pipe — A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.

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"H"	The cross-sectional shape of a weld at a skelp.
Manual shielded electric arc process welding	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
Mitre welds	Welds which join two lengths of pipe at an angle point in such a manner that the axis of both lengths of pipe proceed in a straight line to the point of intersection.
Nominal diameter (size)	A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
Nominal pressure	A numerical designation which is a convenient round number for reference purposes. All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
Pinhole	A very small hole indicating a flaw in the weld.
Pipe end bevel	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
Pipework	Includes all pipes, joints, specials, fittings and valves.
Skelp	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
Special	Any pipe other than a straight pipe. Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
Straight pipe	A straight pipe of uniform bore and of standard or non-standard length.
Welding icicles	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

3.2 Abbreviations

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI	:	American Iron and Steel Institute
DN	:	Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)
DS-AW	:	Double submerged-arc welded
FBE	:	Flanged both ends
FOE	:	Flanged one end
ID	:	Internal diameter
MS	:	Mild Steel
OD	:	Outside diameter, which shall mean the internal diameter + 2x(lining thickness + pipe wall thickness)
p.e.	:	Plain ended.

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PN	:	Nominal working pressure (eg. PN 10 = 1 000 kPa)
Scab	:	Unbonded piece of plate in tight contact with the plate
SS	:	Stainless Steel
t	:	Wall thickness of pipes
TP	:	Test pressure
WP	:	Weld preparation

4 Requirements

4.1 Materials

4.1.1 General

Specials and fittings shall be of the types shown on drawings or billed and, unless otherwise required in terms of the Amendments, they and their couplings shall be capable of withstanding the applicable test pressure. All specials and fittings shall be supplied complete with couplings and jointing material.

4.1.2 Types of steel

Unless otherwise billed or shown on drawings, specials and fittings shall be manufactured from the following materials:

4.1.2.1 Nominal Diameter equal to or less than 150 mm

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

4.1.2.2 Mild Steel

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

4.1.2.3 3CR12 Corrosion Resistant Steel

3CR12 corrosion resistant steel plate shall have a No.1 finish and shall be supplied ex-factory ready pickled and passivated.

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4.1.2.4 Stainless Steel

Stainless steel shall be either EN Grade 1.4301 (304L stainless steel) or EN Grade 1.4401 (316L stainless steel).

4.1.2.5 Super Duplex Stainless Steel

Duplex stainless steel shall be either EN Grade 1.4162 (2101) or EN Grade 1.4462 (2205). Super Duplex stainless steel shall be EN Grade 1.4410 (2507).

4.1.3 Flanges

Flanges on pipe ends, where applicable, shall be manufactured from the same material as the pipe, unless otherwise specified in the Amendments.

Where mild steel flanges are specified, flanges shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

4.1.4 Certification

The Contractor shall submit to the Engineer the steel maker's certificates covering all steel used in the manufacture of the specials as required in Clause 4.4 of SANS 719. In addition, all information relevant to pipework fabrication shall be made available to the Engineer during the course of the manufacturing process.

4.2 Design

4.2.1 General

The Contractor shall be responsible for the design of all specials in accordance with the general arrangement shown on the drawings and/or described in the Bill of Quantities and in conformity to BS 534. He shall submit his design calculations and shop drawings to the Engineer for approval before manufacturing commences. The design of saddle type reinforcement shall be in accordance with AWWA M11.

Specials shall be fabricated by welding from pipes which have been tested to SANS 719 and that conform to the requirements applicable to the Manufacture of medium-pressure steel pipes.

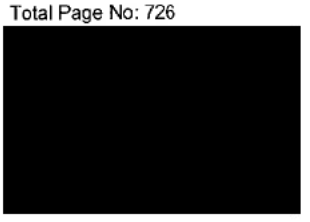
Lifting eyes (lugs) shall be welded to all unwieldy specials and to all specials of DN 600 and larger to facilitate handling and minimise damage to the protective coating.

4.2.2 Wall thickness

Specials shall be designed so that 50% of the minimum yield stress of the steel is not exceeded under maximum working pressure and so that 75% of the minimum yield stress of the steel is not exceeded under maximum surge pressure.

An OD/t ratio of more than 100 will not be permitted unless specifically indicated otherwise on the drawings or in the Bill of Quantities.

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For all branch connections (tees) the plate thickness of the barrel and branch shall be such that the maximum stress shall not be greater than that for an uncut pipe of the theoretical required minimum thickness. Where it is more economical to provide external reinforcement in the form of collar type rings or crotch plates, as shown on the drawings, these forms of reinforcement shall be used to achieve the same results

4.2.3 Bends

Unless otherwise indicated on the drawings or scheduled in the Bill of Quantities, the dimensions for bends shall be determined in accordance with AWWA C208.

Bends shall either be smooth formed (hot bent) or segmented. The maximum angle between oblique butt-ends of segments for mitred bends shall not exceed 22.5°. Cut-and-shut bends are not permitted. Segmented bends shall be classified as short, medium and long with radii equal to one, two or three diameters respectively. All bends shall be of the long radii type, unless otherwise shown on the drawings or specified in the Amendments or Bill of Quantities.

Mitres for bends (kinks) of 10 degrees and less shall be made in the field as part of the pipe laying operation for buried pipelines.

4.2.4 Branches and Nozzles

The attachment of reinforcement to the pipe branches shall be by full penetration welding. The extent and positioning of external reinforcement is to be determined in accordance with AWWA M11.

Branch connections shall be as remote as possible from the seam weld on the barrel and shall generally be placed as follows, except where specifically indicated to the contrary on the drawings:

For air valve tees the centre lines of the air valve branch and the barrel shall intersect at right angles or vertically, as shown on the drawings, depending on the type of tee specified. The branch shall be flanged and have a nominal diameter greater than 50% of the main pipe diameter.

For scour valve tees the branch, consisting of a 90 degree bend, shall be located centrally on the pipe invert and point vertically downwards with the horizontal section at right angles to the barrel of the pipeline. The branch flange shall be set so that the scour valve spindle points vertically upwards, as shown on the drawings.

Nozzles shall be "stub in" in accordance with ANSI B31.3 and of minimum size DN25. Such nozzles shall be threaded to BSPT and provided with appropriate reinforcement. The Contractor shall ensure that the design will withstand the test pressure of the system.

4.2.5 Reducer Pieces

Taper pieces shall not have more than two longitudinal weld seams and shall have a maximum angle of divergence of 10 degrees, as shown on the drawings.

4.2.6 Pipe Supports

Supports for pipework, valves and specials inside chambers and pump stations shall be designed by the Contractor to adequately secure the pipework to the walls and floors. Details and locations of the supports shall be submitted for approval by the Engineer.

4.2.7 Dimensions

The dimensions of the pipe specials and fittings are shown on the drawings.

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4.2.8 Provision of Cadwelding Pads

Where specials are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

4.2.9 Shop Drawings

The Contractor shall, before issuing of shop drawings for manufacture, provide detailed pipework layout drawings for approval in principle by the Engineer. Such drawings shall contain general arrangements and assemblies for the pipes, pipe auxiliaries, pipe specials and valves and include materials schedules, standard parts, etc. Drawings shall provide all the information necessary to demonstrate full compliance with the drawings and specifications and to facilitate subsequent submission of shop drawings free of fit-up error. The Contractor shall be fully responsible for determining the actual dimensions of the specials.

Pipe layout drawings shall incorporate all relevant prime and subsidiary dimensions (primarily, but not necessarily limited to, face-to-face dimensions).

Drawings shall be prepared to acceptable industry standards, an example of which shall be submitted for approval before draughting commences. Due account is to be taken in preparing drawings of the necessity, inter alia, to facilitate straight-forward subsequent fit-up on site, without undue site trimming and site preparation for butt welding, so minimizing also the necessity for extensive site repairs to, or extensions of, internal and external corrosion protection.

Only after approval of final pipework layout drawings by the Engineer shall shop drawings for manufacture of pipes and specials commence. For subsequent approval by the Engineer these shall be in such detail as is appropriate for manufacture. No manufacturing of pipework shall be permitted without approval of the shop drawings by the Engineer.

Approval by the Engineer of any drawing shall not relieve the Contractor of responsibility for correct manufacture and subsequent fit-up on site.

4.3 Jointing

4.3.1 Flexible Couplings

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings.

A coupling shall be able to withstand without failure a hydrostatic test pressure of twice the working pressure specified for the pipe for which the coupling is required, and coupling flanges shall be capable of withstanding without damage all stresses caused by proper tightening of the bolts. Rubber rings shall comply with the relevant requirements of SANS 974: Part I and shall have a hardness of 66 to 75 IRHD.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

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4.3.2 Flanges

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;

Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

4.3.3 Insulated Flanges

Where called for, insulating flanges and materials shall be arranged as set out in Code of Practice No. SAECC/1 or SANS 15589-1.

The design, manufacturing, supplying, installation and testing of the insulating flanges complete with spark gap arrestors shall be in accordance with drawing no. 1A-C6-066 and to the approval of the Engineer. Insulating flanges shall be provided at locations as indicated on the Drawings.

All insulating gaskets, irrespective of pressure rating, shall be full-face gaskets to prevent foreign material from collecting and creating a bridge, thus shorting out the isolation.

4.3.4 Loose Flanges

Loose flanges for welding onto steel pipes on Site shall be manufactured from at least the same steel as specified for the pipes and shall be in accordance with SANS 1123 where applicable (see also 4.3.2), or alternatively in accordance with BS EN 1092.

Loose flanges shall be suitable for field welding to pipes and specials and shall conform to 4.3.2 in respect of attachment.

4.3.5 Gasketing

Each flanged pipe and fitting of less than DN 400 and rated for PN 16 or less shall be supplied complete with one insertion piece (gasket) of the appropriate diameter and made of a material that is suitable for the maximum test pressure, and one set of bolts, nuts and washers.

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Unless otherwise specified in the Amendments, asbestos gaskets in accordance with BS 1832 Grade B, and having a minimum thickness of 1,5 mm, shall be supplied for working pressures not exceeding PN 16.

Where working pressures exceed PN 16, and for DN 400 and over, rubber "O" rings dimensioned in accordance with BS EN 1092 Section 3.1, Fig. 4 for Types G and H flanges, shall be supplied to suit appropriately machined flanges.

Where flanges have not been machined in accordance with the above, spiral wound gaskets, style CG to BS 3381 shall be used. The external ring shall be made of carbon steel and electro plated. The metal windings shall consist of Grade 316 L stainless steel with asbestos filler.

Where flanges with flat faces as specified in 4.3.2, paragraph 1, are jointed, the gaskets shall be of the type manufactured by HPE and as specified below:

The gasket shall consist of a seal ring made from ultra high molecular weight polyethylene (UHMWPE) (section 10 mm x 5 mm minimum) which fits snugly inside a 3 mm thick x 30 mm wide (minimum) flat steel outer ring. The reuse of UHMWPE seal rings is inadmissible.

The outer ring shall consist either of:

A mild steel ring, hot-dip galvanized in accordance with SANS 121 to a minimum mean coating thickness of 65 µm. The finish shall be of even thickness to ensure that the ring bears evenly throughout between the two flanges.

or

A 3CR12 steel ring where specified in the Amendments.

4.3.6 Bolts, Nuts and Washers

Bolts and nuts shall comply with the relevant requirements of SANS 1700 or, where high strength friction grip bolts are specified in the Amendments or considered necessary by the Contractor, the bolts shall comply with the requirements of BS 3139, and their use and design shall be as specified in BS 3294: Part 1 and BS 4604.

Locking devices for nuts shall be provided wherever there is a possibility of the nuts becoming loose during service. Bolts shall be of sufficient length for at least two screw-threads to protrude from the nut when assemblies are fully tightened. Two washers complying with SANS 1700 shall be supplied with each bolt.

All bolts, nuts and washers shall be of a material with equal or better corrosion properties than the pipe materials being joined. All anchor bolts and nuts shall be Grade 316 stainless steel or as approved.

4.3.7 Screwed Joints

The threads for screwed joints shall comply with the relevant requirements of SANS 1109. Male ends shall have taper threads and female ends shall have parallel threads.

4.3.8 Plain Ended Specials

Each plain ended or spigot ended special, as shown on the drawings, shall be supplied with one sleeve coupling (or such other type of coupling as is shown on the drawings) to suit the particular pipe with which the special mates. The coupling shall fit the larger end of the barrel in the case of a reducer.

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4.4 Plant

All specials and fittings shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipework consistently in accordance with the specifications.

Manufacturing at only one works will be permitted. No site fabrication of specials, other than kinks of 10 degrees or less on buried pipelines, will be permitted.

4.5 Fabrication

4.5.1 Qualified Welders

Only qualified welders, certified as having passed the qualification tests as specified in Clauses 6.1 to 6.7 inclusive of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

4.5.2 Welding

Welding and inspection of welds shall be in accordance with Clauses 7 to 11.4 inclusive of API Standard 1104 or alternatively, SANS 10044: Part III. Where radiographic inspection is specified in the Amendments, the procedure followed shall be in accordance with Clause 11.1 of API Standard 1104. Only qualified radiographers as specified in API Standard 1104 shall be employed to do the radiography.

All butt welds and branch fillet welds on specials shall where practicable have an internal weld. The weld bead of this internal weld shall not protrude above the prolongation of the original inside surface of the special by more than 1 mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

4.5.3 Preparation of Special Ends for:

4.5.3.1 Mechanical Couplings

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

4.5.3.2 Fillet Welds

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.5.3.1.

4.5.3.3 Butt Welds

Specials which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.

For specials to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

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4.5.3.4 Bevelling

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

4.5.3.5 Flanges

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

4.5.4 Rectification of Defects

If a special fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the special to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a special subsequent to hydraulic testing, the repaired special shall be retested in accordance with Clause 5.3.2 Hydraulic testing of this specification.

4.6 Coatings and Linings

Coatings and linings of specials shall be undertaken in accordance with the requirements of Specification SPE-JJ-0003.

4.7 Marking

Upon fabrication, each special shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

(a) Pipe reference number

(b) Contract number

(c) Date of manufacture

(d) Outside diameter

(e) Wall thickness/pressure rating

(f) Grade of steel

(g) Coating type and nominal thickness

(h) Lining type and nominal thickness

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(i) Mass of uncoated and unlined special in kg/m

(j) Applicable drilling tables stamped on the periphery of all flanges

(k) Bends shall have their "centre plane" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying.

4.8 Storage, Handling and Transport

4.8.1 Handling and Rigging

Specials shall be protected against damage at all stages from manufacture to delivery. Particular care shall be taken to protect the ends of all specials against denting.

In the transportation, loading and unloading of specials, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that specials and their protective linings and coatings are not damaged.

Specials shall be so transported, stored and handled that they are not overstressed at any time and fittings are not damaged in any way. All thin-walled and soft-coated specials shall be handled with particular care and shall be so stored that they are not subjected to concentrated pressure from stones or other objects. Specials damaged or cracked in any way shall be removed from the Site at no cost to the Employer.

If cradles are used to transport the specials they must be rubber lined to avoid damage to the coating. During transportation specials shall be safely secured.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

4.8.2 Protection of Pipe Ends

Satisfactory temporary end covers shall be provided for the protection of flanges, prepared ends of plain-ended fittings, and threads, and to prevent damage to the internal lining during transportation and during handling on Site.

4.8.3 Material that Deteriorate under the Action of Sunlight

All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weather-proof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived products.

5 Compliance with Requirements

5.1 Facilities for Testing

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

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The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any special under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

5.2 Quality Assurance

All steel specials shall be fabricated and tested in accordance with an approved quality control plan and procedure. The quality assurance of all specials rated over PN 16 shall be in accordance with ISO 9002 and the manufacturer shall be in possession of a current ISO 9002 certificate.

Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

(a) Material certification

(b) Non Destructive Evaluation (NDE) testing

(c) Verification of tolerances

(d) Workmanship

(e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)

(f) Material identification

(g) Personnel certification (including welders and NDE)

(h) Welding procedures and certification

(i) Weld preparation

(j) Compliance with drawings

(k) Hydrostatic testing

5.3 Inspections

5.3.1 Visual Inspections

All finished pipework shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

5.3.2 Hydraulic Testing

When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every special is to be tested to a hydrostatic pressure test of P,

Where P = the lesser of: $2 \times 0.85 \times Y \times t/D$ or 7 MPa

Y = Minimum Specified Yield Stress (MPa)

t = Nominal Wall Thickness of pipe (mm)

D = Nominal Diameter of Pipe (mm)

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Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipe specials shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe special shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The special will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the special shall be re-tested. Should the special, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.

5.3.3 Non-destructive Testing

Non-destructive testing shall be in accordance with Section 9 of API Specification 5L.

On completion of the hydrostatic testing (see 5.3.2) and before the ends of the specials are bevelled, non-destructive tests shall be carried out on all manual or semi-automatic welds, as follows:

All welds shall initially be radiographically tested (X-rayed) over 100% of the weld length. When consistently acceptable results are obtained, the number of welds to be so tested may be reduced on a sound statistically controlled basis by mutual agreement between the Engineer, Inspectorate and Contractor. At least 10% of all welds shall be radiographically tested.

Repairs to welds (see 4.5.4), shall be radiographically tested (X-rayed) over the full length of the repair.

Each radiograph, the test-pieces and results and interpretations of examinations and tests shall be submitted to the Engineer within 24 hours of the particular examination or test.

5.3.4 Testing of Specials

Where hydrostatic testing of specials is not practicable, the welds shall be subjected to 100% dye penetrant tests to determine surface cracks, and/or where ordered by the Engineer, to one of the tests specified in 5.3.3 to determine internal defects. Dye penetrant testing shall be done as specified in Subclause 7.2.1 of SANS 1200 L.

5.3.5 Magnetic Particle Testing

Where requested by the Inspectorate, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

5.4 Inspectorate

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of specials supplied.

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5.5 Marking Procedure

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

5.6 Coatings and Linings

The testing of the coatings and linings of specials shall be undertaken in accordance with the requirements of Specification SPE-JJ-0003.

6 Tolerances

Refer to Clauses 4 and 5 above.

7 Testing

Refer to Clause 5 above.

8 Measurement and Payment

8.1 Basic Principles

8.1.1 Corrosion Protection

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

8.2 Billed Items

8.2.1 Supply of Specials

Unit: ..... number (No)

Specials will be measured by the number of each type, class, and size.

The unit rates shall cover the cost of the provision of each special, complete with couplings and/or other jointing materials as appropriate, and for the design of all specials including all drawings and shop drawings.

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for the supply and delivery to Site of any additional couplings and jointing materials which may be required for the connection of the specials.

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Annexures

Appendix A. Applicable Standards

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104	American Iron and Steel Institute - Standard for welding pipelines and related facilities
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639	Covered electrodes for the manual metal-arc welding of carbon and carbon-manganese steels
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : Wrought carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294	The use of high strength friction grip bolts in structural steelwork : Part 1 : General grade bolts
BS 3381	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1 and 2
BS 4360	Weldable structural steels
BS 4604	The use of high strength friction grip bolts in structural steelwork (metric series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002	Quality systems. Model for quality assurance in production, installation and servicing
SANS 62	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 974	Rubber joint rings (non-cellular)
	Part I : Joint rings for use in gas, water, sewer, and drainage systems

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SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS 1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice

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General specification

Manufacture Of Medium Pressure Steel Pipes
Specification number: SPE-MP-7002

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1 Scope

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel pipes of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments to this Specification.

2 Normative References

2.1 Supporting Specifications

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

a) Amendments;

b) SANS 1200 Series of Standardized Specifications;

c) SANS 1200 L: Medium-pressure pipelines (see Clause 1 above)

d) Specification SPE-MP-7001 : Design and manufacture of medium pressure steel specials

e) Specification SPE-JJ-0003 : General Corrosion Protection

f) Specification SPE-CC-7003 : Laying and Jointing of Medium Pressure Steel Pipes and Specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the manufacture of pipes using either submerged arc spiral welding or longitudinal welded "cans" rolled from low carbon or steel plate and joined by submerged arc circumferential welding to form suitable pipe lengths.

3 Definitions and Abbreviations

3.1 Definitions

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply:

Cut-and-shut bend — A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)

Fitting

a) A special or valve.

b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.

Flexible pipe — A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.

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"H"	The cross-sectional shape of a weld at a skelp.
Manual shielded electric arc process welding	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
Nominal diameter (size)	A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
Nominal pressure	A numerical designation which is a convenient round number for reference purposes. All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
Pinhole	A very small hole indicating a flaw in the weld.
Pipe end bevel	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
Pipework	Includes all pipes, joints, specials, fittings and valves.
Skelp	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
Special	Any pipe other than a straight pipe. Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
Straight pipe	A straight pipe of uniform bore and of standard or non-standard length.
Welding icicles	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

3.2 Abbreviations

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI	:	American Iron and Steel Institute
DN	:	Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)
DS-AW	:	Double submerged-arc welded
E-RW	:	Electric-resistance welded
FBE	:	Flanged both ends
FOE	:	Flanged one end
ID	:	Internal diameter
MSEAP	:	Manual Submerged Electric Arc Process
MS	:	Mild Steel
OD	:	Outside diameter, which shall mean the internal diameter plus 2 x (lining thickness + pipe wall thickness)
p.e.	:	Plain ended.

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PN	:	Nominal working pressure (eg. PN 10 = 1 000 kPa)
SA-AW	:	Semi-automatic arc welded
SAW	:	Submerged arc weld
Scab	:	Unbonded piece of plate in tight contact with the plate
SS	:	Stainless Steel
t	:	Wall thickness of pipes
TP	:	Test pressure
WP	:	Weld preparation

4 Requirements

4.1 Materials

4.1.1 General

Steel pipe shall be manufactured in accordance with SANS 719:2011 Edition 3.2, except as added or amended hereunder. Where the amendments hereunder are in conflict with SANS 719, the amendments shall take precedence.

4.1.2 Chemical Composition (SANS 719, Clause 4.2)

Delete Clause 4.2 and replace with:

Unless otherwise billed or shown on drawings, pipes shall be manufactured from the following materials:

Nominal diameter equal to or less than 150 mm:

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

Nominal diameter larger than 150 mm:

Table 1a

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

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Flanges on pipe ends, where applicable, shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

4.1.3 Physical Properties (SANS 719, Clause 4.3)

Insert in the first sentence after "the requirements given in table 1" the following:

"and table 1a".

4.1.4 Certification (SANS 719, Clause 4.4)

Add the following sentence:

"All information relevant to pipe fabrication shall be made available to the Engineer during the course of the manufacturing process."

4.2 Design

4.2.1 Dimensional Requirements

4.2.1.1 Pipe Length (SANS 719, Clause 5.1.1)

4.2.1.1.1 General (SANS 719, Clause 5.1.1.1)

Add the following under Clause 5.1.1.1:

"Unless otherwise specified, all pipes shall be manufactured in one fixed standard length between 9 m and 19.5 m. The standard lengths of pipes supplied shall be 9.14 m, 12.19 m or 18.28 m."

4.2.1.1.2 Random Lengths (SANS 719, Clause 5.1.1.2)

Delete the wording of Clause 5.1.1.2 and replace with:

"Pipes of random length will be accepted subject to their total length not exceeding 10% of the supplied length for each category of pipe and subject to the length of each pipe being within 10% of a standard pipe length.

Standard pipes from which samples for destructive testing have been cut may be jointed together by butt-welding to form single pipe lengths of the required standard length.

Each change in steel grade, pipe diameter or wall thickness will be classes as a separate category."

4.2.1.1.3 Exact Lengths (SANS 719, Clause 5.1.1.3)

The exact lengths of pipes shall be to a tolerance of -0 mm and +50 mm.

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4.2.2 Dimensions (SANS 719, Clause 5.1.2)

Insert the following after b):

"The tolerances on outside diameters of pipe ends for pipe diameters greater than 1250mm and less than 2230mm shall be as for pipes of 1250mm diameter (refer to Table 3 of SANS 719)."

4.2.3 Wall Thickness (SANS 719, Clause 5.1.3)

Delete "+10% or – 8%" and replace with:

"+13.5% or – 0%"

4.2.4 Pipe Ends (SANS 719, Clause 5.1.5)

Add at the beginning of Clause 5.1.5 the following:

"Pipes shall be supplied with each end complying with one of the following criteria:

a) Bevel ended to be joined by field welding

b) Plain ended to be joined by flexible couplings

c) Bell and spigot (plain) ended to be joined by fillet weld as specified in the Amendments and Additions or Bill of Quantities

d) Flanged ends to be joined by bolts, nuts and washers.

Where both ends are specified as bevel ended or plain ended the requirements of SANS 719 Clause 5.1.5 shall apply.

Bell and spigot ends will generally be specified on pipe diameters of 508 mm or smaller.

The welding requirements for the preparation of these pipe ends shall comply with Clause 4.4.7 of this specification."

4.2.5 Flanges

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

a) Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;

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b) Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

4.2.6 Provision of Cadwelding Pads

Where pipes are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

4.3 Plant

Pipes shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipes consistently in accordance with the specifications.

4.4 Fabrication

4.4.1 General

Only qualified welders, certified as having passed the qualification tests as specified in Clause 6 of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

4.4.2 Forming (SANS 719, Clause 5.2.1)

Delete the sub-clause and replace with the following:

"Unless otherwise specified in the Amendments and Additions, pipes shall be formed in accordance with one of the following forming techniques:

a) Electric resistance welding (ERW). This technique may be used for pipes ranging in outside diameter from 219mm to 610mm and ranging in wall thickness from 3.5mm to 12mm.

b) Submerged arc welding (SAW). This technique may be used for manufacturing spirally welded pipes ranging in outside diameter from 219mm to 2230mm and wall thicknesses ranging from 4.5mm to 18mm.

Where automatic submerged arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside of all pipes.

The number of longitudinal weld seams on pipes shall not exceed 1 for pipes up to and including DN 1000, and 2 for pipes larger than DN 1000 up to DN 2200.

The fabrication of larger diameters and/or use of thicker plate using these techniques may be agreed between the Manufacturer and the Engineer. In both techniques, circumferential joints shall be at least 1.5m apart and longitudinal welds of mated sections shall be at least 30° apart."

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4.4.3 Welds (SANS 719, Clause 5.2.2.1)

Add the following as the first sentence:

"All X-grade steel is to be welded in accordance with API 1104 'Welding of Pipelines and Related Facilities'."

4.4.4 Weld Reinforcements (SANS 719, Clause 5.2.2.2.7)

All butt welds and branch fillet welds on pipes shall where practicable have an internal weld. The height of the inner weld shall not exceed 1mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

4.4.5 Seams

Longitudinal seams, spiral seams and shop girth seams shall all be butt welded.

4.4.6 Rounding of Pipe and Sizing of Ends

If it is necessary to reshape pipes after they have been welded, reshaping shall be performed by rerolling or by pressure. Reshaping of pipes by dropping or hammering is not permitted. Sizing of pipe ends to come within specified end tolerances is permitted. This may include expanding pipe ends either mechanically or hydraulically up to a maximum of 1,5% of its original diameter.

4.4.7 Preparation of Pipe Ends for:

4.4.7.1 Mechanical Couplings

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

4.4.7.2 Fillet Welds

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.4.7.1.

4.4.7.3 Butt Welds

Pipes which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.

For pipes to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

4.4.7.4 Spigot and Socket

Spigot and socket ends shall be rolled or fabricated from plate, sheet or special sections to the required shape without hammering. Longitudinal or spiral welds on the inside of the socket and the

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outside of the spigot shall be ground to plate or sheet surface for a distance not less than the depth of insertion of the spigot into the socket.

4.4.7.5 Bevelling

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

4.4.7.6 Flanges

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

4.4.8 Rectification of Defects (SANS 719, Clause 5.2.3)

Add the following to Clause 5.2.3:

"If a pipe fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the pipe to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a pipe subsequent to hydraulic testing, the repaired pipe shall be retested in accordance with Clause 5.5 Hydraulic testing of this specification.

Dents shall, where practicable, be jacked out."

4.5 Coatings and Linings

Coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification SPE-JJ-0003.

4.6 Marking (Sans 719, Clause 7)

Delete this clause and replace with the following:

Upon fabrication, each pipe shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

a) Pipe reference number

b) Contract number

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c) Date of manufacture

d) Outside diameter

e) Wall thickness

f) Grade of steel

g) Coating type and nominal thickness

h) Lining type and nominal thickness

i) Forming technique

j) Length

k) Mass of uncoated and unlined pipe in kg/m

l) Applicable drilling tables stamped on the periphery of all flanges

In addition to the hard stamping, all pipes shall be clearly marked with the unique reference number in appropriate height characters in durable paint on a black background at one end of each pipe. The supplier's and Employer's name and logo shall be stencilled on each pipe.

Where specified in the Amendments, all pipes shall also be clearly marked with colour bands to reflect the grade steel and wall thickness."

4.7 Storage, Handling and Transport

4.7.1 Handling and Rigging

The plant and rigging equipment used for the handling of pipes shall be such that no pipe shell is over-stressed during any operation.

In the transportation, loading and unloading of pipes, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that pipes and their protective linings and coatings are not damaged. In particular, the use of excavation equipment for handling of pipes will not be permitted.

Coated pipes shall be moved with the use of padded slings of width sufficient to prevent damage to the coating. The slings shall be at least 500mm wide for pipes up to DN600, 600mm wide for pipes of DN700 and up to DN1200, and 800mm wide for pipes of DN1400 and larger, or as approved by the Engineer. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets and any other equipment liable to damage the coating shall not be used.

Slings shall be suitably rated for the loads to be handled and in good condition. The use of deteriorating and frayed slings is prohibited.

All pipes are to be lifted and handled with the aid of a "spreader" lifting beam. Special care shall be taken to ensure that no damage occurs to pipes or coatings as a result of pipes sliding on or hitting adjacent pipes. The dragging or skidding of pipes in contact with the ground is not permitted.

If cradles are used to transport the pipes they must be rubber lined to avoid damage to the pipe coating.

During transportation pipes shall be safely secured to its final destination with slings of an adequate width.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

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4.7.2 Dunnage and Storage

Whenever pipes are stacked or otherwise stockpiled or are transported (unless special cradles are used), use shall be made of suitably resilient material as dunnage which shall not disintegrate or deteriorate when exposed to the elements for prolonged periods. Pipes of 6m length shall be stacked with a minimum of 2 dunnage supports. Pipes of 9m and 12m lengths shall be stacked with a minimum of 3 supports (one support at each pipe end and one at mid-span). Pipes of 18m length shall be stacked with a minimum of 4 supports at equal spacing. The supports shall have a minimum width of 500mm for pipes up to DN500 and 1000mm wide for larger pipes. The length of the support shall be a minimum length of 1.5 times the diameter of the pipe to be supported and shall be profiled to match the coated outside radius of the pipe. Pipes shall be stacked with a minimum clearance of 50mm between adjacent pipe walls and a minimum of 200mm clear of the ground.

Pipes shall be stacked with sufficient supports to prevent permanent longitudinal deflections or deformation of the pipe body in excess of 2 per cent of the pipe diameter. Pipes shall also be stacked in a manner that limits loading on lower layers of pipes. Any pipe showing permanent ovality as a result of surcharge loading shall be rejected. Dents causing a protrusion in excess of 3mm into the interior of a pipe may also result in the pipe being rejected.

Each class and size of pipe shall be stacked and stored separately.

Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or the permanent deformation of coatings. Coated steel pipes shall not be stacked more than two pipes high, each layer separated by bolsters.

The number of layers of bare steel pipes in a stockpile shall not exceed:

$$N = \frac{1730.f.t}{(D-t)^2}$$

Where N is the permissible number of layers, D is the outside diameter of the pipe in mm, f is the guaranteed minimum yield strength in MPa for the steel plate, and t is the nominal wall thickness in mm.

Any material which is not delivered and off-loaded on Site in the same condition as it left the factory may be rejected by the Engineer.

4.7.3 Protection of Pipe Ends

Before transportation all pipes are to be fitted with end caps made from plastic or other suitable material. Each end cap must remain in place until its pipe has been laid and the pipe end is no longer open to the elements. It must, therefore, remain in place until it is no longer needed to protect the pipe from ingress of foreign material.

In addition, bevel-ended pipes are to be fitted with bevel protectors before leaving the Manufacturer's premises. These are to remain in place until removed to permit the welding operation.

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5 Compliance with Requirements

5.1 Facilities for Testing

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any pipe under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

5.2 Quality Assurance

All steel pipes shall be fabricated and tested in accordance with an approved quality control plan and procedure. Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

(a) Material certification

(b) Non-Destructive Evaluation (NDE) testing

(c) Verification of tolerances

(d) Workmanship

(e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)

(f) Material identification

(g) Personnel certification (including welders and NDE)

(h) Welding procedures and certification

(i) Weld preparation

(j) Compliance with drawings

(k) Hydrostatic testing

5.3 Inspections

5.3.1 Visual Inspections

All finished pipes shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

5.3.2 Dimensions (SANS 719, Clause 6.1.1)

Add the following as the first sentence:

"The outside diameter, ovality and straightness of each pipe is to be checked in accordance with this clause."

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5.3.3 Welds (SANS 719, Clause 6.1.2)

Add the following at the end of the clause:

"The welds of each pipe are to be tested using one of the two options below. If not specifically stated elsewhere, pipes manufactured by ERW are to be tested as per Option 2 and spirally welded pipes as per Option 1.

a) Option 1 (excluding ERW pipes)

100% of the welds of all pipes shall be tested by fluoroscopic means. Where defects are detected they shall be adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

b) Option 2 (ERW pipes)

100% of the welds of all pipes shall be tested by ultrasonic means. Where defects are detected in a pipe by means of ultrasonic testing, the defection section of pipe shall be 100% re-tested by means of X-ray and adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

For rail, road, river and stream crossings, 100% of the total length of all welds shall be examined radiographically."

5.4 Destructive Tests (SANS 719, Clause 6.2)

At least one set of the three tests described in SANS 719, Clauses 6.2.1, 6.2.2 and 6.2.3, shall be carried out for each pipe diameter and wall thickness combination. The Engineer may require that, after the first pipe, every 500th subsequent pipe of each diameter and wall thickness combination be tested.

5.5 Hydraulic Test (SANS 719, Clause 6.3)

Delete this clause and substitute with the following:

"When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every pipe is to be tested to a hydrostatic pressure test of P,

Where P = the lesser of: $2 \times 0.85 \times Y \times t/D$ or 7 MPa

Y = Minimum Specified Yield Stress (MPa)

t = Nominal Wall Thickness of pipe (mm)

D = Nominal Diameter of Pipe (mm)

Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipes shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The pipe will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the pipe shall be re-tested. Should the pipe, after repair, fail to pass the second hydraulic test the Engineer may order its rejection."

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5.6 Inspectorate

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the pipe manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of pipes supplied.

5.7 Marking Procedure

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

5.8 Coatings and Linings

The testing of the coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification SPE-JJ-0003.

6 Tolerances

Refer to Clauses 4 and 5.

7 Testing

Refer to Clause 5.

8 Measurement and Payment

8.1 Basic Principles

8.1.1 Corrosion Protection

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

8.1.2 Pipes Tested to Destruction

Pipes tested to destruction and the repair of the tested pipes for use in the Works, if ordered by the Engineer, will be measured and paid on a daywork basis.

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8.2 Billed Items

8.2.1 Supply of Pipes

Unit: ..... metre (m)

The supply of pipes will be measured by length. The maximum length measured will be equal to the length as laid, no deductions being made for specials and valves and no extra length measured for waste. (See Subclause 8.2 of SANS 1200 L)

Separate items will be billed for each diameter and wall thickness.

The unit rates shall cover the cost of the fabrication and supply of the pipes, complete with couplings where applicable, the cost of handling where applicable, and the cost of factory testing, inspection and transportation to Site and shall, where it is necessary to limit ovality to within the specified limits, also cover the cost of bracing the pipes internally.

Separate items are provided in the Bill of Quantities for the laying, jointing, testing and commissioning of the pipes.

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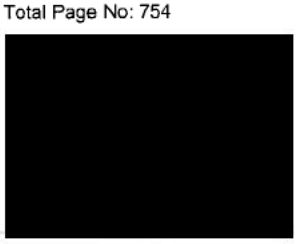
Annexures

Appendix A. Applicable Standards

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104	American Iron and Steel Institute - Standard for welding pipelines and related facilities
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639	Covered electrodes for the manual metal-arc welding of carbon and carbon-manganese steels
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640 Wrought	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294 1 :	The use of high strength friction grip bolts in structural steelwork : Part General grade bolts
BS 3381 and 2	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1
BS 4360	Weldable structural steels
BS 4604 (metric	The use of high strength friction grip bolts in structural steelwork series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002 and	Quality systems. Model for quality assurance in production, installation servicing
SANS 62 size	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719 duties)	Electric welded low carbon steel pipes for aqueous fluids (ordinary

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SANS 974	Rubber joint rings (non-cellular) Part I : Joint rings for use in gas, water, sewer, and drainage systems
SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice

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General specification

Laying and Jointing of Medium Pressure Steel Pipes and Specials
Specification number: SPE-CC-7003

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1 Scope

This Specification covers the laying and jointing of electrically welded low carbon steel pipes and specials of diameter up to 2 280 mm, for transporting water and sewage under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with Specifications SPE-MP-7001 and SPE-MP-7002.

This Specification contains clauses that are generally applicable to the laying and jointing of medium-pressure steel pipes and specials. Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

2 Normative References

2.1 Supporting Specifications

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

(a) Amendments;

(b) Specification SPE-MP- 7002: Manufacture of Medium Pressure Steel Pipes;

(c) Specification SPE-MP-7001: Design and Manufacture of Medium Pressure Steel Specials;

(d) Valves specifications;

(e) Flow meter specifications;

(f) Specification SPE-JJ-0003: General Corrosion Protection;

(g) Standards listed in Appendix A.

3 Definitions and Abbreviations

For the purposes of this Specification the definitions and abbreviations given in the specifications listed in 2.1 shall apply.

4 Requirements

4.1 Materials

4.1.1 General

Refer to Subclause 4.1.1 of SPE-MP-7001 and Subclause 4.1.1 of SPE-MP-7002.

Pipes and fittings shall be of the types specified in the Bill of Quantities or in the project specification and, unless otherwise required in terms of the project specification, they and their couplings shall be capable of withstanding the applicable test pressure specified in the Amendments. All pipes and fittings shall be supplied complete with couplings and jointing material.

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Satisfactory temporary end covers shall be provided for the protection of threads, flanges, and prepared ends of plain-ended pipes and fittings, and to prevent damage to internal lining during transportation and during handling on Site.

4.1.2 Flanges

Refer to Subclauses 4.1.3 and 4.3.2 of SPE-MP-7001 and Subclauses 4.1.2 and 4.2.5 of SPE-MP-7002.

4.1.3 Insulating Flanges

Refer to Subclause 4.3.3 of SPE-MP-7001.

4.1.4 Gaskets

Refer to Subclause 4.3.5 of SPE-MP-7001.

4.1.5 Bolts, Nuts and Washers

Refer to Subclause 4.3.6 of SPE-MP-7001.

4.1.6 Bricks

Bricks shall be obtained from an approved manufacturer and shall be either general purpose (special), burnt clay, or engineering bricks that comply with the applicable requirements of SANS 227, or Class S14 calcium silicate bricks that comply with the applicable requirements of SANS 285.

The Contractor shall submit to the Engineer samples of the bricks he intends using in the construction of the Works. The samples of bricks that are approved will be retained by the Engineer.

4.1.7 Precast Cylinders

Precast cylinders may be of spun concrete, glass reinforced polyester, or PVC, except where particular materials are required in terms of the Bill of Quantities or the project specification. Precast concrete cylinders shall comply with the applicable requirements of SANS 1294. Sectional spun concrete cylinders shall comply with the requirements for pipes of SC type, Class A, of SANS 677. Jointing between cylinders shall be of the interlocking self-centring type suitable for sealing.

4.1.8 Concrete

Concrete shall comply with the requirements of SANS 1200 G or SANS 1200 GA, as applicable.

4.1.9 Welding Rods

The Contractor shall supply all the necessary welding electrodes, which shall be of the shielded type. The chemical composition of weld metal and parent metal shall be similar. Electrodes that show signs of deterioration or damage shall be removed from Site and replaced at the Contractor's expense. Electrodes shall comply with the requirements of BS 639.

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4.1.10 Corrosion Protection

Refer to Specification SPE-JJ- 0003.

4.1.11 Records of Materials on Site

The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site. The record shall at least denote the reference number, size, pressure class, location in the pipeline, date and condition of delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.

Where pipes, specials and fittings are delivered without reference numbers, same shall be provided by stencilling, labelling or other methods approved by the Engineer.

4.2 Plant

4.2.1 Packing

Goods shall be suitably packed in such a manner as will ensure safe and efficient transport by road or rail, and the Contractor shall include in his prices for whatever packing may be necessary in this respect. Small items particularly liable to damage or loss in transit should be crated. All crates and packing material shall, after use, become the property of the Employer, unless distinctly specified otherwise, or if returnable, shall be so at the Contractor's expense.

4.2.2 Handling and Rigging

The plant and rigging equipment used by the Contractor for the handling and placing of pipes shall be such that no pipe shell is over-stressed during any operation covered by the specification.

4.2.3 Setting Out

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

4.2.4 Site Equipment

The Contractor shall furnish all equipment, tools, and supplies, including the necessary welding electrodes. Welding machines shall be operated within the amperage and voltage ranges recommended for each size and type of electrode. Any equipment that does not meet these requirements shall be repaired or replaced upon request of the Engineer. (Refer also API 1104 Clause 1.3.)

4.2.5 Testing

The Contractor shall provide all equipment, materials, tools, and fittings required for the performance of the tests given in Clause 5.

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4.3 Methods and Procedures

4.3.1 Laying

4.3.1.1 General

The pipelines shall be laid and bedded to even grades and to the levels and alignments shown on the drawings or as directed. It shall be laid centrally in the trench in such a manner that the side allowance conforms to the applicable value specified in Clause 8 of SANS 1200 DB. For ease of inspection and testing the pipes shall be laid with the manufacturer's class and quality identification marks visible from the top of the trench, unless, in the case of large pipes, the position of lifting eyes render this impracticable.

Control of laying and bedding shall be by means of boning rods and sight rails or an acceptable laser beam device. Sight rails shall be painted black and white and shall be fixed securely and accurately.

4.3.1.2 Damage

Each pipe, pipe special and fitting shall be thoroughly cleaned and carefully examined for damage and defects prior to laying. Should any damaged or defective pipe, pipe special or fitting be laid, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

During laying, the anti-corrosion lining of pipes being joined by butt welding shall be protected against damage by foot traffic or weld spatter, to the satisfaction of the Engineer and in the manner described in Clause 4.3.2.4.6.

4.3.1.3 Keeping Pipelines Clean

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipe(s). At the close of each day's work, or at any time when work is suspended for a significant period, the last laid section of the pipeline shall be plugged, capped or otherwise tightly closed until laying is recommenced.

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct that the pipe interior be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately before laying. Once a section of pipeline has been cleaned, it shall be sealed off and not be entered again unless permitted by the Engineer.

During laying and jointing of pipes and until the pipeline has passed the required acceptance tests and the trench has been backfilled, the trench shall be kept in a state which, in the opinion of the Engineer, is reasonably dry.

The Contractor shall at his own expense make good any damage to valves and fittings or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

4.3.1.4 Depths and Cover

Unless otherwise specified in the Amendments, shown on the Drawings, or ordered by the Engineer, the minimum cover for pipelines shall be 1.0 m.

The minimum clearance between the outside of a pipeline being laid and the outside of any other pipe that it crosses shall be 300 mm. Where this requirement conflicts with the requirements for cover over

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the pipeline the Contractor shall ask the Engineer for written instructions and shall carry out the work in accordance with those instructions.

4.3.1.5 Cold Stresses and Deflection In Pipe Curvature

Pipes shall be laid free from cold stresses. No deflections shall be taken in curvature of pipes, but shall be taken with approved bends with exceptions as hereinafter specified. All deflections in pipes with flexible couplings shall not exceed those recommended by the manufacturer of the couplings after making allowance for ground movements.

4.3.1.6 Mitres to Effect Pipe Deflections

All deflections in the axis of butt-welded steel pipelines of 10 degrees or less shall be made by mitring equally the ends of the two pipes to be joined so that the maximum mitre in any one pipe shall be 5 degrees. Where the total deflection is 3 degrees or less, the mitring may be made in one pipe end only. Ends to be mitred shall be carefully and accurately marked and then either machine cut or machine planed. Hand planing will not be permitted. After mitring, the pipe ends shall be re-chamfered as described in Clause 5.1.5 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1,5 mm and the maximum gap shall be 3,0 mm. After mitring all pipe ends shall be thoroughly cleaned before the field weld is carried out.

4.3.1.7 Cold Bends

Where the Engineer gives written approval for cold bends on pipes with diameters of 450 mm and smaller, they shall be made by the cold stretch method in such a manner as to preserve the cross-sectional shape of the pipe. The minimum radius of any such bend shall be twenty five times the outside diameter of the pipe. Approved bending shoes shall be used for bending of the pipes.

4.3.1.8 Snaking

Snaking into the trench of butt-welded sections of steel pipeline which has been factory lined and/or coated will not be permitted without the written approval of the Engineer.

4.3.1.9 Stringing of Pipes

The Contractor shall ensure that pipes are strung in accordance with a method statement to be approved by the Engineer. The method statement shall cover the proper placement by diameter, wall thickness and specifications. Any movement of pipes resulting from failure to comply with the approved method statement shall be rectified at the Contractor's expense.

4.3.1.10 Handling and Transporting

Pipes and specials shall be handled as specified in Clause 4.8 of SPE-CC-7001 and Clause 4.7 of SPE-MP-7002.

Wrapped pipes shall be protected from grit and other sharp objects while the pipe is in the trench prior to bedding. Walking on wrapped pipes will not be allowed. The Engineer may reject any length of wrapping on which physical damage due to any cause whatsoever is visible.

Cement mortar lined pipes shall not be moved or transported for a period of 14 days after the date of lining.

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4.3.1.11 Skids

Skids of sufficient number shall be supplied to support the pipe to proper height. If a pipe is supported over the trench, skids shall be of sufficient length to prevent collapsing of the trench and of sufficient strength to carry the pipe.

For coated pipe a sufficient number of skids shall be used to prevent damage to the coating.

4.3.2 Jointing Methods

4.3.2.1 Flexible Couplings

The joints of steel pipes by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends and couplings are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.

Joints shall be made and couplings assembled to the manufacturer's instructions. Two-thirds of the number of coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly, using a torque wrench.

Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the coupling shall be carefully centred over the pipe ends.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

4.3.2.2 Flanged Joints

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flanges. Flanges shall be installed truly square to the axis of the pipe.

In the jointing of steel pipes with flanges, special care shall be taken to align, grade and level the pipes, specials and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Epoxy paints shall not be removed from flange faces. Insertion pieces that have accurately cut holes for bolts shall be placed to form a continuous one-piece ring between the flanges. Bolts shall be tightened up to ensure uniform bearing on the insertion. Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Wherever loose flanges are welded onto pipelines, the Contractor shall ensure that the inner lining is restored to the thickness specified for such lining and that the new repaired lining is soundly jointed to the existing lining.

In making the joint the Contractor shall ensure that the flanges are truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and tightened equally at opposite ends first. The Contractor shall ensure that the correct jointing materials, i.e. gaskets and bolts and nuts are available when required. The gaskets shall be in accordance with Subclause 4.3.5 of SPE-MP-7001. In the case of insulated joints the insulated materials shall be arranged as set out in Code of Practice No. SAECC/1.

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Flanged fittings shall be so installed that there are no stresses induced into the pipework specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

4.3.2.3 Bolts and Nuts

Bolts and nuts shall be in accordance with Subclause 4.3.6 of SPE-MP-7001.

Only correct diameters and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts and bolt heads. The length of bolts and studs shall be such that approximately two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite-grease compound immediately prior to assembly.

4.3.2.4 Field Welding

4.3.2.4.1 General

Field welding of pipes which have been lined will only be permitted in pipes of DN 450 and larger where a man is able to enter the pipe to make good the lining after welding and testing in accordance with Clause 5.1 has been completed. Pipes of lesser diameter may be field welded where concrete linings will be made after the pipeline has been laid and all welds have been tested and approved.

At the discretion of the Engineer, roll welding will be permitted, provided an alignment is maintained by use of skids or of structural framework to accommodate two or more lengths of pipe with an adequate number of roller dollies to prevent sag in the pipe. The entire root bead, however, shall be made with the pipe in a stationary position.

All pipes welded in the trench shall be properly laid and aligned before welding commences. Joint holes shall be excavated at all field welds. The Contractor shall not lift the pipe to provide adequate access for the welders to enable them to weld the joint.

The alignment of abutting ends shall be such that the offset will not exceed 1.5 mm. Line up clamps shall be used for joint "fit-ups". The use of "bridges and wedges" or any method that may induce unnecessary stresses will not be permitted.

Both ends of coated and lined pipes shall be wrapped for a distance of at least 800 mm on either side of the weld by means of an asbestos mat or other approved material to ensure that weld spatter or other damage is not caused to the coating and lining during the welding process. The pipe trench shall be kept free of all dirt and water in the vicinity of the weld until after all corrosion protection measures have been completed and approved.

Destructive testing as specified in Clause 5.1.2.2 shall be carried out. The Contractor shall submit to the Engineer for approval a full procedure specification as detailed in API 1104 Clause 5.3 prior to any field welding being allowed.

4.3.2.4.2 Welding Procedure and Qualification of Welders

Welding shall only be done by qualified welders who satisfy the requirements of API Std. 1104, Clause 6 and who have been tested at the Contractor's expense by an Independent Inspectorate.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications. Each welder shall mark the pipe adjacent to the weld with the figure assigned to him.

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Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

As far as practicable all out of trench welding shall preferably be done by an automatic submerged process and the Contractor shall provide all necessary plant to carry out this process. Manual submerged electric arc process (MSEAP) welding may be used where in-trench welding is done.

Pre- and post-heat treatment for welding shall be in accordance with API Std. 1104 if required by same and the Contractor shall provide an approved shield to protect the pipe joint from wind and weather during heat treatment and welding.

4.3.2.4.3 Line Up

Pipes shall be lined up in such a manner as to prevent damage thereto. If the pipe to be used has a longitudinal seam, these seams shall be staggered by not less than twenty degrees and welded sections, or single lengths, shall be assembled in such a manner that this seam shall remain in the top quadrant of the pipe during coating operations and after lowering into the trench.

4.3.2.4.4 Cleaning of Pipe Ends

Before welding, all foreign matter shall be removed from the bevelled ends. If any of the ends of the pipe joints are damaged to the extent that satisfactory welding contact cannot be obtained, the damaged pipe ends shall be cut and bevelled with an approved bevelling machine. These field bevels of pipe ends shall be made to the satisfaction of the Engineer. Should laminations, split ends, or other defects in the pipe be discovered, the joints of pipes containing such defects shall be cropped, repaired, or removed from the line as designated by the Engineer.

4.3.2.4.5 Weather Conditions

No welding shall be carried out during rain or high wind unless the welder and joint are adequately protected and sheltered, to ensure that the welding is not impaired.

4.3.2.4.6 Protection of Paintwork

Before welding commences, a suitable apron at least 800 mm wide shall be wrapped around both sides of the area to be welded to ensure that weld spatter or fallout from arc weld does not damage the paintwork.

During the welding of joints, the Contractor shall ensure that either rubber mats or other suitable material is laid in the pipe invert of epoxy lined steel pipes to protect the lining against damage by traffic or fall-out from arc welding at the joint. The mats shall be placed the full distance from the point of access up to the point of weld or weld inspection and shall be of sufficient width.

Workmen shall wear soft rubber soled shoes before entering lined pipes. Care shall be taken not to stroke arcs on the epoxy lined areas adjacent to the weld joint. Immediately before welding of joints, the protective tape between the ends of concrete or epoxy linings and coatings and pipe ends shall be removed.

4.3.2.4.7 Butt-welding

Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding. All welding of joints shall comply with API Std. 1104 and only approved type welding rods shall be used.

If backing rings are used, they shall be placed in position and wedged up or adjusted so that the pipe ends are completely circular and properly mated. The space between abutting pipe ends, when

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aligned for welding, shall be such as to ensure complete penetration without burn-through. For pipes having the same dimensions, the spacing shall be approximately 1,5 mm.

The alignment of the abutting pipe ends shall be such as to minimize the offset between pipe surfaces. For pipes of the same nominal wall thickness, the offset shall not exceed 1,5 mm. Internal line-up clamps shall be used wherever practicable and may be removed after the root bead is 50 % completed, provided that the completed part of the root bead is in segments of approximately equal lengths, spaced about the circumference of the pipe. If conditions make it difficult to prevent movement of the pipe, or if the weld will be unduly stressed, the root bead shall be completed before releasing clamp tension.

External line-up clamps shall be used where it is impracticable to use internal line-up clamps. Partial root beads made when using external clamps shall be uniformly spaced about the circumference of the pipe, and shall have an accumulative length of not less than 50% of the pipe circumference before the clamps are removed.

Tack-welding shall be carried out to maintain the root gap and position of the pipe ends during the welding proper. The number of tack-welds shall be kept to a minimum but shall not be less than four around the circumference of the pipe.

After proper preparation and tack-welding, the root bead shall be carried out followed by successive filler passes, and capper finish pass in accordance with the approved welding procedure.

The filler and finish beads shall be deposited by an acceptable method and each filler bead shall be approximately 3 mm in thickness. Completed welds shall have a reinforcing of not less than 0,8 mm and not more than 1,5 mm above the pipe surface around the entire perimeter of the weld, and the width of the finish or cover shall be not more than 3 mm greater than the original groove.

The number of beads required shall be governed by the wall thickness of the pipe, so that the completed weld will have the reinforcement previously specified; provided, however, that each weld shall consist of at least three beads. No two beads shall be started at the same point. No mitre welds will be permitted, and all welds are to be at ninety degrees (± 5 degrees) to the axis of the pipe. All slag and scale shall be removed from each bead for visual inspection immediately after each bead is run.

In all field butt-welds where it is possible to work inside the pipe, the inside weld shall be done first. The chemical composition of weld metal and parent metal shall be similar and the inner weld metal or reinforcement shall not extend more than 1 mm above the inside metal surface of a pipe or special, and any excess shall be removed by grinding.

Defects caused by stray welding arc flashes shall be removed by grinding, provided that the pipe wall thickness is not reduced to less than the specified minimum thickness, otherwise the portion shall be cut out and repaired.

4.3.2.4.8 Fillet Welding

Welding shall be as for butt-welding as applicable. All pipes of DN 600 and over shall be welded on both the outside and the inside.

4.3.2.4.9 Welding Alongside the Trench

The Contractor may butt-weld factory coated and/or lined steel pipes together alongside the edge of the trench to form continuous welded pipeline sections up to a maximum length of 45 m and to lower each section into the trench, provided the pipe, coating and/or lining are in no way damaged during these operations and provided furthermore that the deflection of the pipe barrel at any point during any stage of the operation does not exceed 2% of pipe outside diameter.

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The linings and coatings of factory coated and/or lined pipes jointed together outside the trench shall be made good at these joints outside the trench.

4.3.2.5 Repair of Welds

Rectification of defective welds shall be in accordance with API Std. 1104 and to the satisfaction of the Engineer. All costs related to the repair of defective welds shall be borne by the Contractor. Defective welds shall be repaired immediately once they are found to be defective. The Engineer has the right to stop the Contractor proceeding with further pipe laying in the event of the Contractor delaying the rectification of defective welds. Furthermore, no consideration will be given to any claims arising from delays in construction resulting from such action.

4.3.3 Installation of Specials and Fittings

4.3.3.1 General

Welding shall comply with API Std. 1104. All specials and other fittings shall be installed in accordance with the drawings and instructions of the Engineer. Where "slip-on" or sleeve couplings are to be fitted, all surfaces shall be thoroughly cleaned to a smooth finish, care being taken to remove as little of the protective coating as possible.

4.3.3.2 Bends

Bends shall be installed true to line, level and deflection and shall be anchored in concrete where required to counteract thrust. Bends shall normally be supplied with "centre planes" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends in laying.

4.3.3.3 Tees

Tees for air valves shall be installed with branch barrels pointing vertically upwards. Tees for scour valves shall be installed with branch barrels pointing vertically downwards or at the gradients indicated on the drawings. Tees for off-takes shall be installed as shown on the drawings.

Field installation of the off-takes from the pipelines for air and scour valve connections or any other form of off-take shall not be permitted. All tees for these off-takes and connections shall be factory manufactured.

4.3.3.4 Flanges

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flange. Flanges shall be installed truly square to the axis of the pipe.

4.3.3.5 Insulated Flanged Joints

Insulated flange joints shall be provided and installed by the Contractor where specified or instructed by the Engineer. The Contractor shall supply all materials, labour and plant required and shall complete and prove that each insulated joint after installation in the pipeline has a resistance well in excess of the resistance to earth of the pipeline on both sides of the insulating joint.

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4.3.3.6 Temporary Closure Pipes

Temporary closure pieces shall be of the same standard, diameter and wall thickness as the pipeline, except where otherwise specified or instructed by the Engineer.

4.3.3.7 Permanent Closure Pipes

Permanent closure pipes shall be provided and installed as pipe laying proceeds. They shall be either butt welded to adjacent pipes, or jointed to access pipes, fittings or specials by means of slip-on couplings.

4.3.4 Temporary Sealing of Pipeline

4.3.4.1 Night-Caps

Metal night-caps shall be used to close off all ends of each laid section of pipework when work is stopped at the end of each day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline. The night-caps shall consist of a steel plate welded into a half slip-on coupling which shall be provided with a sufficient number of lugs to secure the ring and gasket and shall be strong enough to withstand external water and earth pressure in the event of flooding or collapse of earth. The joint shall be watertight.

The Contractor shall also, at his own expense, blank-off all air valve, scour valve and off-take tees with at least 6 mm thick blank flanges which shall be bolted with at least four bolts to tee flanges or shall be fixed to plain ended tee branches by using half couplings welded to the blank flanges. These shall be watertight and shall not be removed until the valves or other fittings are about to be fitted.

Notwithstanding the use of night-caps, the Contractor shall, at his own expense, make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall, at this own expense and to the satisfaction of the Engineer, clean the interior of the pipeline of such contaminants.

4.3.5 Prevention of Flotation

Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipe work due to storm runoff or groundwater entering the trench before backfilling has been completed.

Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

4.3.6 Installation of Valves and Meters

Unless otherwise specified or directed, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves and meters shall be correctly set, supported, and placed in position as the work proceeds, and shall be properly jointed to their respective pipes.

All valves and fittings shall be left in working order and shall be housed in chambers as shown on the Drawings.

Valves, meter bodies and fittings shall be supplied, painted externally and internally. The Contractor shall thoroughly clean damaged exterior painted surfaces of all valves, meter bodies and fittings of all

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dirt, rust, grease and other foreign matter by methods approved by the Engineer and shall make good all damaged surfaces in accordance with the requirements of SPE-JJ-0003.

Valves requiring special adjustment after installation such as self-closing valves shall be commissioned by representatives of the valve manufacturers. Similarly, meters shall be commissioned by the respective suppliers after installation by the Contractor.

All valves and meters supplied under separate contracts, which are defective due to circumstances outside the Contractor's control shall be repaired, replaced or modified by the valve suppliers who will also be responsible for commissioning the valves.

The mass of valves or water meters shall at no time be carried by the pipe, the flange or the coupling. Support stools shall be constructed as soon as practicable after the installation of valves and meters, and shall generally be constructed of steel, concrete or masonry work. Where fabricated steel stools are approved or specified they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Engineer's approval. Supports shall be welded to the pipe only where specified and linings of pipes and specials shall be made good after welding.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Engineer in writing.

Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Engineer may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted.

Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate.

4.3.7 Casings, Anchor Blocks and Chambers

4.3.7.1 Concrete Casing

Where the Engineer requires pipes to be encased in concrete, a strength 20 MPa/19 mm, or such other strength as is scheduled, shall be used. The work shall be done as follows:

Concrete casing shall be discontinuous at flexible couplings in the pipeline.

The pipe trench for the concrete encased pipeline shall be excavated to the depth below the bottom surface of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade.

The in situ concrete bed 150 mm thick shall be cast and the pipeline laid thereon true to line and level leaving a gap nowhere less than 50 mm between the pipe and the bed.

After jointing the pipes shall be secured to steel loops left in the bed. Concrete shall then be punned under and around the pipes from one side only until the bottom quarter of circumference of the pipes is in contact with the concrete bed.

The pipe shall be tested in accordance with the applicable tests given in Clause 5, care being taken to ensure that the pipe do not move during testing.

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After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position up both sides of the pipe. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings.

No earth filling over the concrete shall be commenced until at least 7 days after the concrete has been placed.

4.3.7.2 Anchor Blocks

At tees, bends, terminal valves, end caps and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered or shown on the Drawings. Unless otherwise specified or indicated on the Drawings, anchor/thrust blocks and pedestals shall be constructed of 20 MPa/19 mm concrete or such other class as is scheduled.

The concrete shall be well punned round the pipe and, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above for anchor/thrust blocks at the Contractor's expense unless an item is scheduled to cover payment for overbreak. Care shall be taken to leave the joints accessible. No anchor/thrust blocks and pedestals shall be concreted until the approval of the Engineer has been obtained.

4.3.7.3 Valve Chambers

Valve chamber shall be constructed as indicated on the Drawings. Concrete chambers shall be constructed in accordance with the relevant clauses of SANS 1200 G or GA.

Lifting and relaying of existing pipes

4.3.8 Brickwork in Chambers and Manholes

Each chamber and manhole shall be built to the details shown on a particular drawing or as shown on the applicable type drawing. The walls shall be constructed in an approved bond comprising header and stretcher courses with the fair face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

The bricks shall be well soaked in water immediately before being laid and the course of bricks last laid shall be well wetted before fresh bricks are laid upon it. All walls shall be carried up regularly so that no part of the walling is more than 1,3 m higher than any adjoining wall.

Joints shall be flushed up solid at every course throughout the whole width of each course, which shall be laid on a solid bed of mortar of thickness not exceeding 10 mm, and, when applicable, the joints shall be raked out as the works proceeds to form a key for plaster.

Mortar for brickwork and plasterwork shall be composed of one part of cement to three parts of sand. Sand shall be clean pit sand free from clay and other impurities and, if so directed, shall be properly screened and washed.

If required, step irons for a manhole shall be built into the straight of the wall at 300 mm intervals staggered right and left in vertical rows. Cast iron fittings shall be bitumen painted. Each cast iron cover and frame shall be grouted solidly onto the shaft. Concrete surrounds of each manhole shall be finished off to suit surrounding surfaces.

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4.3.9 Lifting and Relaying of Existing Pipes

Where shown on the drawings and where scheduled, existing pipes and fittings that are to be removed shall be lifted and the materials recovered as far as is practicable. The pipes and couplings shall be removed from the trench and placed in the Contractor's site store where they shall be cleaned, sorted, and listed. A copy of the list of undamaged material recovered shall be handed to the Engineer.

Unless, in terms of the contract, other pipes are to be laid in the same trench, each trench shall be backfilled as specified in SANS 1200 DB.

Where recovered pipes are scheduled to be relaid, rubber rings, insertion packings, damaged joints, and rusted bolts shall be replaced.

Before they are relaid, an acceptable number of pipes shall be tested for compliance with the requirements of the application specification for resistance to hydraulic pressure.

4.3.10 Disinfection of Potable Water Pipelines

After completion of the laying and testing, each potable water pipeline shall be disinfected. The Contractor will be required to submit a detailed method statement for approval by the Engineer. A minimum requirement will be that the method statement deals with the method of dosing and how the dosing rate will be controlled to ensure a uniform distribution throughout the pipeline to be disinfected, the chemicals to be used, the anticipated range of dosing rates and equipment to be used, and the name and qualification the Contractor's person supervising the disinfection.

Once a successful hydraulic test of the entire pipeline has been achieved and the connections have been completed, the pipeline shall be drained. The pipeline shall then be re-charged in accordance with Clause 5.1.3.5 "Initial Filling of the Pipeline". Whilst being charged, a sodium hypochlorite solution shall be introduced into the pipeline in such a manner as to ensure that a theoretical total chlorine concentration of at least 25 ppm (mg/l) is achieved throughout the pipeline.

Once the entire pipeline has been filled in this manner, it shall be left for a 24-hour period. Thereafter, total chlorine concentrations shall be measured at each scour and off-take point. A concentration of 20 ppm total chlorine will be considered acceptable. Should this concentration not be achieved at all scours and off-takes, the Contractor shall take all steps considered necessary by the Engineer to achieve satisfactory disinfection, at his/her own cost.

Once satisfactory disinfection has been achieved, the pipeline shall be drained via the scour valves (or by other means approved by the Engineer) and sufficient sodium thiosulphate (typically 1 part of total chlorine) shall be dosed into the scour-wet wells to fully neutralise the chlorine before discharging to watercourses.

The pipeline shall then be re-charged in accordance with the stated procedure and, after 24 hours, samples will be taken by the Engineer for analysis (at no cost to the Contractor). Should the following limits not be achieved, the Contractor shall carry out at his/her own cost, all steps deemed necessary by the Engineer to achieve satisfactory disinfection:

E.coli: Count = 0

Coliforms: Count = 0

Faecal Streptocci: Count = 0

In addition to a), b) and c), the water quality shall meet the requirements for potable water of the local authority or of the authority supplying such water to the area.

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[redacted]

4.3.11 Corrosion Protection

4.3.11.1 Final Painting

After successful hydrostatic testing of the pipeline, and after completion of all construction work under this Contract, all external surfaces of uncoated steelwork and surfaces of all valves and fittings shall be prepared and painted as specified in the relevant clauses of Specification SPE-JJ- 0003. In addition, all surfaces of materials which had received first coats of paint in the course of the Contract in accordance with the specifications shall receive final coats of paint of the same colour or such other colours as may be specified or instructed by the Engineer.

All paint used shall be out of the original containers of the manufacturer and such containers are to be brought onto the site unopened. No adulteration will be permitted and paints shall be used strictly in accordance with the manufacturer's instructions.

Painting shall not be done in wet or humid weather.

4.3.11.2 Butt-Welded Steel Pipes

As soon as practicable, but not more than 24 h after the welding of joints in the field has been approved and accepted by the Engineer, the internal lining of pipes and specials shall be made evenly continuous over the joints.

Materials for this work shall have the same properties as those used respectively for the adjacent lining or coating and shall be so applied that the finished work over the joint shall have the same quality as specified respectively for the adjacent lining or coating and shall be capable of passing the same tests as specified for adjacent lining or coating.

4.3.11.3 Metal Couplings

In addition, all buried metal couplings and all metal couplings located inside chambers, shall be protected with "Denso" petrolatum as per the requirements of Specification SPE-JJ- 0003.

5 Compliance with Requirements

5.1 Testing

5.1.1 General

Testing shall be in accordance with this clause and Specifications SPE-JJ- 0003, SPE-MP-7001 and SPE-MP-7002, as relevant.

As the work proceeds, pipelines shall be hydrostatically tested by means of test equipment supplied by the Contractor.

Each test shall be carried out in the presence of the Engineer or his representative. The Contractor shall be responsible for carrying out all tests and for all expenses incurred.

When carrying out the hydrostatic tests, the Contractor shall ensure that all valves, tees, and bends are properly secured and shored to prevent movement of pipes and fittings and, should any such movement occur, the Contractor shall, at his own expense, reposition and, if necessary, repair the pipes and fittings and the securing means.

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Until each section of the pipeline has been subjected to the hydrostatic test and has complied with the applicable requirement for leakage rate, the pipeline will not be accepted. The hydrostatic test shall be repeated until the Engineer is satisfied that the section under test complies with the said requirement.

5.1.2 Testing of Field Welds

5.1.2.1 Destruction Tests

Tests as specified in API 1104 Clause 6.5 shall be carried out and approved prior to any field welding being done.

5.1.2.2 Radiographic Testing

Radiographic tests and adjudication of test records shall be carried out by an Independent Inspectorate, appointed by the Engineer to act on his behalf. The Inspectorate shall be afforded every facility during the course of pipeline construction and testing to enable the inspection to be carried out effectively. 10% of the total length of all manual field butt welds and 2,5% of the total length of field welds done by an approved automatic process shall be examined radiographically with particular reference to weld intersections, using equipment supplied and staffed by the Inspectorate. All welds on critical sections such as river, rail and road crossings shall be 100% radiographically tested.

The Engineer reserves the right to increase the length of welds to be radiographed if results obtained are not satisfactory or to reduce the length of welds radiographed to a minimum of 4% if the standard of welding is sufficiently high to warrant such a reduction.

The Inspectorate shall process and adjudicate radiographs on site. The standard of acceptability shall be in accordance with API 1104. All welds which are found to be unsatisfactory shall be repaired and 100% re-radiographed at the Contractor's expense. The additional radiography of repaired welds shall not be deemed to be included in the overall 10% or 2,5% radiography.

Field welds may be examined by radiographic inspection as stated in API 1104. Should two or more welders participate in making the weld, the welding foreman and the Engineer's Representative shall decide which welder is responsible for the defective work. The Engineer shall be privileged in the judgement of his inspector to cut out welds for further tests. The test welds (except the initial free test referred to in 5.1.2.1) that meet the Engineer's requirements and specifications when properly tested shall be replaced with a satisfactory tie-in at the Employer's expense. Should any test weld cut from the line prove unsatisfactory to the Engineer when properly tested, it shall be replaced at the Contractor's expense. Test welds shall be cut from the line as soon as practicable after completion to avoid unnecessary delay and expense, and shall consist of an annular ring not less than 230 mm long with the weld in the middle.

When welding the line together at places where the test welds have been cut out, one weld will be used if it is practicable to pull the line back into position; otherwise, two welds will be made by setting in a short length of pipe with a minimum length of 750 mm.

The Contractor shall furnish approved types of machines for testing. A record of the results of each test weld shall be made by the Engineer's inspector and jointly signed by the Engineer's Representative and Contractor's Representative. The Contractor will be reimbursed for extra welds at the rates tendered if scheduled in the Contract as a separate item. Extra welds shall be construed to mean those welds cut out at the Engineer's request which, after specified tests, are found to meet the Engineer's specifications, except those free initial test welds referred to herein.

Claims arising from delays in construction caused by justifiable additional radiography which may be ordered by the Engineer or re-radiography of repairs, will not be considered.

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5.1.2.3 Dye-Penetrant Testings

A 100% dye penetrant test shall be carried out by the Contractor on all field welds except where radiographic testing is undertaken.

The dye-penetrant test shall be carried out in accordance with BS 4416 and as detailed below:

The Contractor shall obtain the approval of the Engineer for the group of dye-penetrant and developer that he proposes to use for the test;

As pipe laying progresses, field welds shall be subjected to the test soon after each weld is completed;

In order to obtain a surface that is dry, clean and free from scale, dirt and grease, the Contractor may grind but he shall not grit blast the surface;

The temperature of the surface to which the developer and the penetrant are applied shall not be below 16°C or above 52°C;

Observations for indications shall be made not less than 15 minutes and not more than 60 minutes after the application of the penetrant;

Any surfaces on which non-relevant indications are observed shall be explored by visual methods and, if considered necessary by the Engineer, such surfaces shall be cleaned and retested; and

Welds that show no relevant trace of dye on the developer will be accepted.

5.1.2.4 Visual Testing

All field welds shall be inspected visually throughout their entire length by the Contractor for signs of possible faults. Full records of the testing of each joint shall be kept by the Contractor and his findings reported to the Engineer. The Contractor shall allow the Engineer and/or the Inspectorate to also inspect up to 10% of the number of field welds visually.

5.1.2.5 Testing of Fillet Welds

In addition to the dye penetrant tests, each fillet weld on pipes of DN 600 and over shall be air and bubble tested by pumping air into the annular space between the welds to a pressure of at least double the specified working pressure. While this pressure is maintained, all welds and connections shall be tested with soap or primer. Defects found during testing shall be repaired by the Contractor, and testing continued all at the Contractor's expense until a satisfactory result is obtained.

The test tapping point shall then be plugged in an approved manner.

5.1.3 Hydrostatic pressure testing

5.1.3.1 General

The pipeline shall be hydrostatically tested on completion of pipe laying and after installation of all valves and fittings. Test sections shall be blanked off by making use of end-caps. Installed isolating valves within the test section shall not be used as end-caps.

The Contractor shall submit to the Engineer a detailed method statement describing the timing, methodology and scheduling of each hydrostatic pressure test to be undertaken. No test shall proceed before approval of such method statement by the Engineer.

If sections of a pipeline are encased in concrete, or where concrete anchor blocks or other structural concrete structures had been provided, the Contractor shall allow for a minimum concrete setting period of 28 days prior to the hydrostatic test being executed.

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The Contractor shall supply water from an approved source for hydraulic testing of the pipeline. Pipelines designed for potable use shall be hydraulically tested and disinfected using potable water. Water used for one filling of the pipeline for hydraulic testing, one filling for disinfection and one filling after draining the disinfection water will be provided by the Employer to the Contractor, free of charge, at the connection points stated in the project specifications. Items have been provided in the Bill of Quantities to cover the cost of receiving and conveying water from the supply point to the test section of pipeline. Additional water supplied by the Employer owing to unsuccessful disinfection and/or hydraulic testing will be charged to the Contractor.

5.1.3.2 Test Pressure and Time of Test

After the pipe trench has been backfilled the pipeline shall be tested in sections between end caps, blank flanges, or other isolating devices, at the pressures appropriate to the pipeline section under test. The Engineer may require that blank flanges or "spades" be inserted and that the pipeline be tested in reduced lengths and, in addition, at the point of maximum pressure.

Unless otherwise specified, shown on the drawings, or approved by the Engineer, the average test pressure for field testing shall be 1,25 times the pressure rating of the pipe.

Where the pipeline is tested in sections, the Contractor will have the discretion to determine the sections in which the pipeline may be tested provided that:

The test sections shall be determined, taking any differences in elevation along the pipeline into account, such that the:

maximum field test pressure at any point along the section is not higher than 1,5 times the pressure rating of the pipe or the maximum field test pressure permitted by the pipe manufacturer; and

minimum field test pressure at any point along the section is not less than the greater of:

the pressure rating of the pipe, or

1,25 times the maximum working pressure at these points.

The first km (+200m,-100m) of pipeline laid is successfully tested before the subsequent section may proceed.

The Contractor shall make due allowance in the construction programme and in the tendered rates for the entire testing operation including for the provision of temporary end stops (flanges or bullnoses) and any other costs associated with testing the pipeline in intermediate sections.

Once filled, the pipe shall be left for 24 hours to permit maximum saturation. The section to be tested shall then be pressurised to the specified pressure and left for a further 24 hours, during which period, the pressure drop (if any) and the quantity of water required to be pumped in to restore the test pressure shall be measured and recorded. In addition, all flexible and flanged joints shall be visually inspected and there shall be no sign of leakage.

At all times when there is water in the pipeline, and particularly during filling, testing and draining of the pipeline, all air valves shall be in operation and their individually isolating valves shall be open.

5.1.3.3 Visible Leaks

Except as allowed in b) the specified test pressure shall be maintained for a period of at least 24 hours (or such longer period as is necessary for inspection of the pipeline) during which period all pipes, pipe specials, joints, and fittings shall be carefully inspected for leaks. All visible leaks shall be made good and any pipe, pipe special, or fitting found to be defective shall be removed and replaced at the expense of the Contractor and such replacement material shall, after installation, be tested at the expense of the Contractor.

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In the case of pipes of DN 400 and under, the test period may be reduced proportionally to the nominal diameter of the pipe, provided that in no case shall the test period be less than 1 hour.

5.1.3.4 Permissible Leakage Rates

The test pressure shall be maintained for a further period of 1 hour after the completion of the test period specified in Clause 5.1.3.3, during which time the volume of water required to be pumped into the pipeline for maintenance of the pressure shall be measured.

The permissible leakage for welded and flanged steel pipelines is zero (0) litres.

5.1.3.5 Initial Filling of Pipeline

The entire process for filling the pipeline at any time during testing or disinfection shall be carried out under the supervision of the Engineer. Under no circumstances will the Contractor be allowed to carry out filling of the pipeline without the supervision of the Engineer, neither shall the Contractor permit any other persons to carry out such filling without the written permission of the Engineer.

Unless otherwise specified or approved in writing by the Engineer, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s.

Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

5.1.3.6 Connections After Testing

The connections of the new pipework to the existing pipework shall only be carried out after the pipeline testing has been completed and accepted by the Engineer. For this reason, testing must be carried out against a blank flange or bullnose end cap at these locations.

5.1.3.7 Remedial Measures

In the event that a pipe section fails a test, the Contractor shall carry out all remedial measures necessary to obtain a successful test of each individual section and the entire pipeline, at his/her own expense. Such remedial measures shall in no way compromise the requirements stipulated in the specifications.

5.1.3.8 Draining of the Pipeline

The pipeline may have to be drained to carry out remedial measures and it must be drained before the disinfection process commences. The pipeline shall be drained via the scour valves in a manner that does not cause erosion of the streambeds or negatively impact on the environment in any way. All such drainage of the pipeline shall be carried out under the supervision of the Engineer.

5.1.4 Commissioning

The pipeline will be considered to have been commissioned and practically complete once all the associated structures are sufficiently complete to carry out their structural and hydraulic function and the hydraulic test and disinfection of the entire pipeline has been successfully completed.

5.1.5 Water Tightness Testing for Chambers

Refer to the SANS 1200 G or 1200 GA, as applicable.

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5.1.6 Tests on Epoxy Linings

Once all work in the pipeline has been completed bar the hydrostatic testing and backfilling, the pipeline shall be cleaned by sweeping with a soft broom and rinsing. Access to this section shall be restricted from this point forward and will only be allowed on the written consent of the Engineer.

Holiday detection testing is to be undertaken by the Contractor on the lining in order to ensure that it remained intact during the transport, handling, placing and backfilling processes. Holiday testing may also be undertaken by the Independent Inspectorate. The testing and repair procedures shall be in accordance with the requirements stipulated in Specification SPE-JJ-0003.

5.1.7 Pipe Coating Integrity Surveys

The Contractor shall perform the pipe coating integrity survey as defined in the cathodic protection specifications.

5.2 Tolerances

5.2.1 General

No deviation will be permitted from the minimum pipe cover specified or shown on the Drawings.

5.2.2 Control Points

For the purposes of this Clause, valves and pipe specials set on the centre line of the pipeline and designated changes in gradient shall be regarded as control points and shall be located with a permissible vertical deviation of ± 100 mm on the centre line. The same deviation will be permissible laterally except where the pipeline is laid at a designated distance from a fence line, kerb line, or boundary, in which case the permissible deviation shall be ± 20 mm.

Unless otherwise directed and subject to a permissible deviation (measured along the centre line) of ± 2 m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

5.2.3 Alignment

PLAN (horizontal alignment): Unless otherwise directed, the permissible deviation from the defined alignment of the pipeline, when measured on the top centre of the pipeline, shall be ± 100 mm or ± 10% of the nominal diameter of the pipe, whichever is the larger, and the permissible deviation per pipe length shall be ± 20 mm.

LEVEL (vertical alignment): The permissible deviation from the designated level at any point on the invert of the pipeline shall be ± 50 mm or ± 10% of the nominal diameter of the pipe, whichever is the larger.

5.2.4 Manholes, Valve Chambers, Etc.

Manholes, valve chambers and the like shall be constructed centrally on the control points and, with the exception of tolerances that affect access to bolts, nuts, etc., with a permissible deviation of ± 50mm on all clearance dimensions. The clearance dimension between the outside of each nut and bolt-head and the inside face of the wall of a structure or any other fitting shall be at least the specified value.

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6 Tolerances

Refer to Clauses 4 and 5.

7 Testing

Refer to Clause 5.

8 Measurement and Payment

8.1 Basic Principles

8.1.1 General

Excavation and backfilling of trenches, and laying of medium-pressure pipelines, will be measured separately under SANS 1200 DB and Clause 8.2 of this Specification.

8.1.2 Night-Caps

No extra payment will be made for night-caps. The supply and use of night-caps will be held to be included in the unit rate tendered for pipe laying.

8.1.3 Permanent Closure Pipes

8.1.3.1 Butt Welding

Where closures are butt welded to other pipes, the cost of cutting the pipe, preparing the end for welding and welding as specified in SANS 719, repairing the lining and coating as specified in Specification SPE-JJ-0003 will be held to be included in the unit rate for laying of pipes.

8.1.3.2 Slip-On Couplings

Where closures are jointed to either access pipes, fittings or specials by means of slip-on couplings, no additional payment will be made for extra cutting of the pipe, preparing the end for welding, welding on the loose collar (approved 150 x 20 mm mild steel, machined round to suit coupling) or making good the lining.

Unless separately billed, the supply, transport and handling of the collar and slip-on coupling will be held to be included in the unit rate for the supply of pipes, fittings and specials.

8.1.4 Extra Welds

Payment for all extra welds shall be covered by variation orders showing the location of the welds according to stake value and other necessary details. Such variation orders shall be signed by the Engineer's Representative and the Contractor's Representative in the field on the day the work is done. No payment will be made for test welds not covered by variation orders as stated above.

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8.2 Billed Items

8.2.1 Lay and Bed Steel Pipes and Specials complete with Couplings

Pipes	Unit:	metre (m)
Specials	Unit:	number (No.)

Pipes will be measured linearly as laid in the trench. No deduction will be made for specials and valves. Separate payment will be made for each type, size and class of pipe laid.

Specials will be measured separately by number of each type.

The unit rates tendered in the Bill of Quantities for laying of pipes and specials shall cover the cost of the following:

(a) Inspecting, accepting, taking delivery, providing storage, taking delivery from storage on site, transporting, handling, inspecting, stringing alongside trench, forming joint ("fox") holes, laying, jointing, cutting, scarfing, cutting mitre deflections up to 10 degrees (5 degrees per side), bevelling, maintaining line and level, jacking for ovality if necessary, provision and use of shield for heat treatment and welding if required;

(b) maintenance of cleanliness including all night caps and temporary blank flanges, etc., necessary to keep the inside of the pipe dry;

(c) removal, where necessary, and making good of lining and coating over the joints;

(d) radiographic examination of field welds and holiday testing of the lining, visual and dye penetrant testing;

(e) testing of welders and issuing of the necessary certificates;

(f) making good all linings and coatings;

(g) hydrostatic testing, testing equipment and anything required to do this work, including temporary end caps and blank flanges;

(h) sterilizing the pipeline where used for potable water;

(i) bolts, nuts, washers, gaskets and insulating material;

(j) supply and installation of steel and or concrete pipe supports (not necessarily shown on drawings);

(k) building in of specials (Refer to Item 8.2.11)

No extra payment over and above the rates tendered in the Bill of Quantities will be made in respect of additional cutting and jointing of pipes required to locate valves, specials, etc., exactly.

No separate payment will be made for the supply and fitting, chipping of lining, cutting, trimming, bevelling and making good on Site of any additional couplings and jointing materials which may be required for the connection of shortened pipe closures, unless specific provision is made in the Bill of Quantities.

The unit rate tendered for laying of steel pipes and specials shall cover the cost of the laying, jointing, etc., as specified and, in addition, for final painting and surface preparation when applicable. No extra-over payment shall be made for protecting metal couplings with petrolatum wrappings as per Specification SPE-JJ-0003.

Notwithstanding the use of night-caps the Contractor shall at his own expense make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall at his own expense and to the satisfaction of the Engineer clean the interior of the pipeline of such contaminants.

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A maximum payment of 85 % of the tendered rate may be made for the completed section of pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 10% of the tendered rate will be made upon successful completion of the pressure testing for the relevant section of pipeline. The final 5% of the tendered rate will be made upon completion of disinfection of the pipeline.

8.2.2 Extra-Over for Mitre Deflections

Unit: number (No.)

Where additional mitre deflections (up to 10 degrees) are ordered by the Engineer, these will be measured by number.

The rate shall cover the all the costs associated with mitre deflections detailed in Item 8.2.1 (a) to (f).

8.2.3 Installation of Valves and Meters

Unit: number (No.)

The unit rate for installation of valves and meters shall cover the cost of taking delivery of these items from storage on site, inspecting each item for visible signs of damage, transporting to the laying site, off-loading, installing and, except where separately billed, of testing and commissioning of the valves and meters in position in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.

No extra payment over and above the rate will be made in respect of any additional cutting, turning and jointing of pipes required for the location of a valve, meter, etc. where a precise position is given on the drawings.

The tendered rate shall also cover all jointing materials and, except where separately billed, support pedestals. The rate tendered for installation of valves and meters shall also include the cost of necessary oiling and greasing of moving parts and for minor routine initial maintenance work such as tightening up leaking glands.

The unit rates shall include for the cost of making good and the repair of paintwork and final painting as specified.

8.2.4 Recover Old Pipeline

Unit: metre (m)

The total length of the pipeline ordered to be recovered will be measured by length for each stated depth range. No deductions will be made for valves, specials, and the like.

The rate shall cover the cost of the excavation and removal of pipes, valves, and fittings from the trench, the handling and transportation to the Contractor's store on site, the cleaning and listing of the salvaged recovered materials, and the backfilling of the trench.

8.2.5 Test and Relay Recovered Pipe

8.2.5.1 Test Recovered Pipes on Site Before Relaying

Unit: number (No.)

The rate shall cover the cost of the provision of suitable testing equipment and the carrying out of the specified test.

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8.2.5.2 Relay Pipeline

Unit: metre (m)

The rate shall cover the cost of transporting, handling, laying, and bedding, as well as the provision of new rubber rings or insertions, as the case may be. Couplings and bolts that have to be replaced will be paid for at daywork rates unless a suitable item such as 8.2.4.3 below has been provided in the Bill or, in the opinion of the Engineer, the need for their replacement arose from the fault or negligence of the Contractor.

8.2.5.3 Joints and Couplings for Recovered Pipeline (Provisional)

Unit: number (No.)

The rate shall cover the provision of complete sets, each comprising a new rubber ring or insertion, as the case may be, as well as all elements of the coupling and bolts that need replacement.

8.2.6 Anchor/Thrust Blocks

Dimensions stated or given on drawing – Unit: No. or Sum

OR

Where, at the tender stage, no detailed drawings or dimensions are given or where only typical drawings are given:

Concrete – Unit: m^3

Formwork – Unit: m^2

Reinforcement – Unit: ton

Except where measured by number or sum, anchor/thrust blocks will be measured as the volume of concrete, areas of formwork, and mass of reinforcement, as relevant, placed to dimensions ordered or given on the drawings and schedules of reinforcement. The relevant terms of Clause 8 of SANS 1200 G or SANS 1200 GA, as applicable, shall apply.

Where measured by number or sum, the rate or sum shall cover the cost of excavation and trimming, formwork, reinforcement (if any), and screeding of top surfaces.

8.2.7 Concrete Casing

Unit: m^3

The concrete will be measured net by volume to the specified width and depth in excess of the external volume of the pipe (i.e. the volume of the pipe will be deducted).

The rate shall cover the cost of formwork (including stop ends at flexible joints), reinforcement (if any) and concrete.

8.2.8 Valve Chambers

Unit: number (No.)

Valve chambers will be measured as complete units.

The rate shall cover additional excavation (see Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB), materials, plant, and labour necessary for the complete construction including the installation of covers, ladders and ancillaries shown on the drawing.

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8.2.9 Manholes

Unit: number (No.)

Manholes will be measured as complete units for which separate items will be scheduled for each type of manhole and depth categories.

The rate shall cover additional excavation, materials, plant, and labour necessary for the complete construction including the installation of the covers, ladders and ancillaries shown on the drawing.

8.2.10 Temporary Closure Pipes (Provisional)

Unit: number (No.)

Temporary closure pipes will be measured as provisional items by number only where ordered by the Engineer.

The unit rate shall cover the cost of the supply, installation, removal and making good of the pipe.

Excavation, backfilling and supply of bedding material will be measured and paid for separately as specified in SANS 1200 DB and SANS 1200 LB.

8.2.11 Items Cast or Built into Concrete

Unit: number (No.)

The building in (or casting into concrete) of the pipes and pipe specials will be measured by the number of each item built in.

The unit rate shall cover the installation of the pipe or pipe special as well as all additional costs of formwork, concreting and fixing of pipes and specials which are not covered by the normal tendered rates for formwork and concrete.

8.2.12 Pipe Lining Integrity Tests

Unit: lump sum (Sum) or metre (m)

Payment for tests on linings will include for all labour, the cost of supplying fuel and production related wearing parts (bucket teeth, cutters etc) for equipment utilised, and materials to perform all tests and repair work as defined in Specification SPE-JJ-0003. Payment for the pipeline section tested and repaired will be certified for payment only on written acceptance of successful testing and repair work as defined in Clause 5.1.6.

8.2.13 Concrete/Steel Valve and Pipe Supports

Unit: number (No.)

Except where billed separately, payment for the supply and installation of concrete or steel supports to valves, meters, pipe specials, etc. shall be included in the rates tendered for the installation of these items.

Where billed separately, the rate for supports shall cover all material, plant and labour required for the supply and installation of the support, including all anchor bolts and jointing material. In the case of steel supports, the cost of the corrosion protection shall be included in the rate tendered for the support.

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Annexures

Appendix A: Applicable Standards

API 1104	:	Standard for welding of pipe lines and related facilities.
SANS 719	:	Electric welded low carbon steel pipes for aqueous fluids (Ordinary duty)
SANS 10044-3	:	The fusion welding of steel (including stainless steel): Tests for approval of welding procedures and production welds.
SANS 1200 G	:	Concrete (structural)
SANS 1200 GA	:	Concrete (small works)
SANS 1200 L	:	Medium-pressure pipelines
SAECC/1		
Specification SPE-MP-7002	:	Manufacture Of Medium Pressure Steel Pipes
Specification SPE-MP-7001	:	Design and Manufacture of Medium Pressure Steel Specials
Specification SPE-JJ-0003	:	General Corrosion Protection

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General specification

Air Valves
Specification number: SPE-MM-7022

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1 Introduction

SPE-MM-7022 specifies the standard requirements for air valves which are used for air release and vacuum break on pipelines and for air release in pump stations.

2 Scope of Works

2.1 General

The equipment installation to be provided by the Contractor shall be configured as shown on any applicable drawings.

2.2 Works to be Provided by the Contractor

The detail of the work for which the Contractor is responsible is specified elsewhere.

3 Normative References

The following documents are applicable to this specification:

(a) Amendments, Additions and Detailed Requirements (SPE-MM-7022).

(b) SPE-MM-0001 - General Mechanical Requirements.

(c) SPE-JJ-0003 – General Corrosion Protection.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4 Equipment Eligibility

The air valves provided shall have a successful record of use in South Africa in similar applications and shall also have had at least three years of technical support in South Africa. Service and spares shall currently be available in South Africa. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

5 Performance Requirements

5.1 Pipelines

Valves shall perform in accordance with the air discharge, air inlet and slam-free conditions specified.

In vacuum break mode, valves shall react immediately in order to prevent the pressure falling to a level which would be unacceptable in terms of the design of the pipeline.

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Valves shall be capable of discharging high volumes of air through a large orifice under pressure during filling of the pipeline.

5.2 Other

Valves shall be capable of releasing small quantities of accumulated air at all line pressures up to and including the rated working pressure of the valve.

The large discharge orifice shall close at a differential pressure of between 4 and 6 kPa in order to minimise transient pressure effects. The valve shall continue to release air at a lower rate.

Valves shall seal drop tight at all line pressures between 0,45 bar and the rated pressure.

6 Operation and Control

Valves shall operate autonomously; i.e. a valve shall not require a servo mechanism to control its operation and shall not require an external power supply.

7 Equipment Construction and Design

7.1 General

Air release valves for water pipework shall be of the non-slam type, Vent-O-Mat RBX, or ARI or equivalent.

Air release valves for wastewater pipework shall be of the non-slam type Vent-O-Mat RGX, ARI or equivalent. Valves for wastewater and related duties shall be specifically designed for the application.

The manufacturer's name, pressure rating, nominal size, serial number, Contract number and the material designations of the body shall be permanently displayed on the valve in the form of a plate of corrosion resistant material securely fixed to the body with corrosion resistant fastenings.

A metal seated, wedge gate isolating valve shall be provided and installed so that the air valve can be isolated during full line pressure. The wedge gate valve shall have the same pressure rating as specified for the air valve.

7.2 Hydraulic Design

Valve design and selection shall ensure that pipe collapse does not occur under a "full bore" rupture condition and, additionally, shall comply with the following criteria:

- Air valves on pipe sizes up to DN 600 shall be designed to ensure that the internal pressure does not drop to less than 8 kPa below atmospheric pressure under a full bore rupture condition.
- Air valves for pipe sizes larger than DN 600 shall be selected on the basis of a rupture condition which shall be agreed with the Engineer.

The criteria for the valve performance shall have been confirmed by a recognized independent authority.

7.3 Construction

Valves shall be flanged. The flange shall comply with the flange specification for the pipeline.

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It shall be possible to remove the valve's working parts without unbolting the bottom flange from the pipeline. Floats and seats shall not, however, require maintenance under normal conditions.

A stainless steel screen shall prevent foreign matter from entering and blocking the air ports.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

8 Fasteners

Fasteners on the valve shall be of stainless steel.

Flange fasteners shall comply with the flange fastener specification for the pipeline.

9 Materials and Coatings

Ductile iron shall be protected with fusion bonded epoxy or Rilsan or equivalent to a dry film thickness of at least 200 micron in accordance with SPE-JJ-0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Floats shall be of HDPE or similar.

Seals shall be nitrile rubber or otherwise approved by the Engineer.

Carbon steels parts shall not be acceptable.

10 Installation

Each air valve shall be provided with a nozzle which shall form an accumulator pocket to capture the air bubbles entrained with the water flow. The nozzle shall be fabricated as an upstand tee and shall have a diameter of at least half the pipeline diameter. The upstand tee's height shall be equal to its own diameter or greater. The upstand shall be flanged and shall be provided with a blank flange. The blank flange shall incorporate a flanged riser which is sized for mounting the air valve onto.

Equipment shall be mounted firm and level.

Installation work shall comply with SPE-MM-0001.

11 Civil and Building Matters

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

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12 Inspections

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

13 Testing Requirements

The valve body shall be pressure tested to 1,5 times the rated pressure of the valve for two minutes and there shall be no visible leaks.

Valves shall be tested for drop tight sealing at the rated pressure and also at a pressure of 0,45 bar above atmosphere.

A certificate indicating these test results and including the valve's serial number shall be provided to the Engineer.

The Contractor shall demonstrate the valve performance in terms of vacuum break, air release during filling and air release under line pressure. One unit of each size shall be demonstrated to the Engineer and the Employer.

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

14 Miscellaneous

Valves shall be protected against damage during transport.

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General specification

Pipework Anchors
Specification number: SPE-MP-7024

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1 Introduction

SPE-MP-7024 specifies the requirements for anchors for pipework to be provided by the Contractor.

2 Scope of Works

See project specification.

3 Normative References

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

(a) Amendments, Additions and Detailed Requirements (SPE-MP-7024).

(b) SPE-MM-0001: General Mechanical Requirements.

(c) SPE-JJ-0003: General Corrosion Protection.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4 Performance Requirements

Pipe anchors shall resist the forces from pressure and from inertial flow changes. The pipe anchors shall restrain and anchor the pipework, valves and other heavy fittings and shall withstand loads and thrust forces and prevent them from being transferred to pump flanges and other equipment which might be damaged or have shortened lifespans.

Pipework shall accommodate settlement, expansion and contraction.

Pipework shall be structurally capable of withstanding the vibration to which it is subjected without fatigue fracture. Vibration shall be restricted to the source and shall not be transferred via pipework.

Pipe supports shall not restrict dismantling of equipment.

5 Design & Construction

5.1 General

In order to achieve the specified performance requirements, the Contractor shall analyse the forces at isolation valves, check valves, bends, reducers and any other cause which are present during normal operation, during dormant conditions, during testing, during start up and during shut down of each pump individually and during operation of the pump station as a whole. The steel pipe anchors shall be designed to transfer all such forces to the concrete structure.

Pipe anchors shall be provided so that pipework does not place any external loading on items of rotating mechanical equipment such as pumps, compressors, etc.

Provision shall be made for settlement as well as for expansion and contraction due to variations in temperature or pressure.

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Pipe anchors shall be designed and located so that when an item of mechanical equipment, such as a pump or blower, is removed, the associated pipework and equipment is still adequately anchored.

Pipe anchors shall be provided at or close to all heavy items such as valves of size DN 200 and larger.

Pipe anchors which only anchor the weight of horizontal pipework may be of the sliding type and shall be vertically adjustable.

Pipework anchors, other than cast-in puddle pipes, shall be of carbon steel or of stainless steel.

Pipe anchors which resist thrust forces shall incorporate doubler plates welded on the pipe and shall be as short as feasible. The doubler plates shall be of the same or greater thickness than the pipe wall thickness and shall be contoured to match the pipe. Other reinforcing designs will also be acceptable.

Low carbon steel pipe anchors shall be fabricated from heavy duty hot rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed. Welds shall be continuous "all round"; i.e. no crevices.

Stainless steel pipe anchors shall be fabricated of plate with a minimum thickness of 4,5 mm or shall be fully triangulated, boxed or closed sections. Welds shall be continuous "all round"; i.e. no crevices.

Where appropriate, 3 mm thick neoprene strips shall be placed between pipes and pipe anchors or clamps to protect the paintwork and to limit corrosion.

Where roller or sliding anchors are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage to the pipe structure from sliding and corrosion.

5.2 Pipe Anchors for Steel Pipework

The maximum allowable spacing between pipe anchors for steel (including stainless steel) pipe of diameter, d [mm], shall be calculated as follows:

Spacing (mm) = 1 500 + 6d.

This applies to pipe only. Valves and other heavy items shall be anchored separately.

5.3 Pipe Anchors for Plastic Pipework

The maximum allowable spacing between pipe anchors for plastic pipe of diameter, d [mm], shall be calculated as follows:

Spacing (mm) = (1 500 + 6d) / 2.

This applies to pipe only. Valves and other heavy items shall be anchored separately.

5.4 Fastening

At least four anchor fasteners shall be provided for the foot of each pipe anchor.

Cantilevered pipe anchors are not preferred. Their spacing between anchor fasteners on the foot shall be not less than one quarter of the cantilevered length. Gussets between the column and the foot are normally required and these shall be positioned so as to minimise the distance between the gusset and the anchor fastener. The requirements in this paragraph do not apply to cantilevered pipe anchors which only provide vertical support.

Pipe anchors shall be aligned using nuts above the foot and stainless steel shims below the foot. Anchor fasteners shall be tensioned when their nuts are tightened; i.e. it is not acceptable to use a nut below the baseframe to position it; and the holding down force shall be loaded into the concrete structure.

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Concrete surfaces under foot plates shall be scabbled before the pipe anchor is placed and shall be blown clean using compressed air immediately before grouting. A space of at least 20 mm shall be left and this space shall be filled using non-shrink grout once alignment has been completed. Grouting shall be done in accordance with the manufacturer's instructions. Alternative designs and installations may be submitted by the Contractor.

5.5 Concrete Anchors

Concrete pipe anchors shall be designed for purpose.

6 Fabrication

Fabrication and welding shall comply with SPE-MM-0001.

Pipe anchors will be inspected by the Engineer after fabrication is complete.

7 Fasteners

Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

Nuts for anchor fasteners shall be provided with both a spring washer and a flat or fender washer.

Fasteners shall comply with SPE-MM-0001.

8 Corrosion Protection

Corrosion Protection shall comply with SPE-JJ-0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Carbon steel shall be hot dip galvanised after all fabrication has been completed.

9 Installation

Installation work shall comply with SPE-MM-0001.

10 Inspections

The Contractor shall make arrangements for the Engineer to inspect the pipe anchors for compliance prior to payment being made.

11 Documents to be Provided

Proposed designs of pipe anchors, preferably indicated on the General Arrangement design drawings, shall be submitted to the Engineer for review prior to manufacture.

The calculations for pipe anchors designed to withstand the thrust from reducers, bends and check valves shall be included.

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General specification

Plunger Valves
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1 Introduction

SPE-MM-730 specifies the requirements for plunger valves of size DN 200 and larger for flow regulation and modulation and which are to be provided by the Contractor.

2 Scope Of Works

See project specification.

The installation shall be configured as shown on applicable drawings.

3 Normative References

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (SPE-MM-730).
- SPE-MM-0001: General Mechanical Requirements.
- SPE-JJ-0003: General Corrosion Protection.
- SPE-MM-6004: Pneumatic and Hydraulic Actuators for Valves and Sluice Gates.
- SPE-MP-7024: Pipework Anchors.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4 Equipment Eligibility

The valves provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Valves which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

5 Performance Requirements

5.1 General

The valve shall be capable of performing the specified duties and shall be rated for continuous operation at those duties unless non continuous operation is specified or is inherent in the system design.

5.2 Pressure Reduction

No cavitation damage shall result at any point in the valve's operating range.

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5.3 Leakage

Valves shall be droptight when closed.

Spindle seals shall not leak.

5.4 Operation

Valves shall operate smoothly, evenly and without snatch. Excessive vibration is unacceptable.

Valves and their method of actuation shall be designed to open and close at a differential pressure equal to the full pressure rating of the valve.

Handwheels shall not require a peripheral force greater than 250 Newtons during operation (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons) at the full differential pressure rating of the valve.

6 Operation and Control

The valve's detailed operating requirements are specified elsewhere.

The plunger operating mechanism shall provide self-locking of the plunger in any position. It shall not rely on the actuator to keep it in position.

Clear indication of current valve position shall be provided.

Valve opening and closing direction shall be indicated.

End of travel indication shall be provided.

Actuated valves shall be provided with manual override. Electric actuators shall also be provided with manual start and stop functions on the actuator.

7 Valve Design and Construction

7.1 General

Valves shall be double flanged.

The manufacturer's name, valve size and working pressure shall be cast on the valve body or otherwise permanently indicated on the valve.

Valves shall be provided with a DN 50 bypass which shall incorporate an isolating valve. The valve shall be a metal seated wedge gate valve and shall be manually operated.

The plunger shall be guided along its complete travel distance.

The elastomer seal shall be out of the water flow path.

The body shall incorporate storage feet and lifting eyes.

The body shall incorporate a drain and an air release. Both shall be of stainless steel.

A control device with slotted or circular orifices shall be provided if the duty is for continuous operation at pressure differences above 80 metres.

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7.2 Gearboxes

Gearboxes shall have ingress protection to IP 55.

Motor driven gearboxes shall comply with SPE-MM-0001. Gearbox service factors shall be chosen in accordance with SPE-MM-0001 or shall comply with the guidelines of AGMA.

Manual gearboxes shall comply with SPE-MM-0001. Suitable gearboxes shall be fitted to achieve the specified operating torque for manual operation.

7.3 Automatic Closing

Valves incorporating a weighted lever for automatic closing shall be provided with a protection cage which completely surrounds the lever up to 1 800 mm above floor level. The lever shall be provided with a double bearing arrangement and shall not be cantilevered on the valve shaft.

7.4 Over-Torque Prevention

A slipping clutch, or equivalent mechanism, shall prevent over torque which would cause damage. Shear pins and other torque limiting devices which have to be replaced after activation are not acceptable.

8 Valve Supports

Each valve of size DN 300 and larger shall be provided with a separate, dedicated pipe support.

The pipe support shall be designed to withstand all thrust forces under all operating conditions unless these forces are directly transferred via pipe flanges to another thrust restraint. Thrust forces shall not be transferred via flange adaptor restraints.

Valve supports shall be of hot dip galvanised steel.

The valve supports shall comply with SPE-MP-7024.

9 Actuator

Actuators shall comply with SPE-MM-6004.

Electric actuators shall comply with the electrical specifications.

10 Pipe Couplings

Adequate couplings shall be provided in order to facilitate dismantling of the valve from the pipework.

The couplings shall not transfer the thrust forces on the valve and shall not be used to support the weight of the valve; i.e. the valve shall be self-supported.

The preferred position for a pipe coupling is upstream of the valve.

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11 Pressure Gauges

One pressure gauge shall be provided upstream of the valve and one shall be provided downstream of the valve.

The gauges shall be positioned so that they provide pressure measurement at the valve even if an upstream or downstream isolation valve has been closed.

The gauges shall comply with SPE-MM-0001.

12 Materials and Coatings

12.1 General

Components shall be designed for corrosion resistance in the application.

Materials shall comply with SPE-MM-0001.

Corrosion protection shall comply with SPE-JJ-0003.

Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be completely clear of ferrous stain and heat tint at commissioning.

Metal plating of ferrous materials is not acceptable.

12.2 Environment

Environmental corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944 2).

12.3 Equipment

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Valve body	Ductile iron for pressure ratings up to PN 40. Cast steel is acceptable for bodies above PN 40.	Internal and external surfaces of the valve body shall be protected with a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 200 micron (i.e. the minimum readings shall not be less than 200 micron). Specialist applied Rilsan coatings and glass flake coatings will also be acceptable.
Plunger	Stainless steel	N/A
Plunger guides	Non-ferrous metal or stainless steel (of a different hardness to the plunger)	N/A
Seal retaining ring	Stainless steel	N/A

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ITEM	MATERIAL	COATING
Linkages	Stainless steel or coated cast iron.	Stainless steel: N/A. Cast iron: Protected by a water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of at least 200 micron (i.e. the minimum readings shall not be less than 200 micron). Specialist applied Rilsan coatings and glass flake coatings will also be acceptable.
Pins	Stainless steel	N/A
Drive shaft	Stainless steel.	N/A
Bushes	Bronze (not brass) or a load bearing engineering plastic.	N/A
Valve trim (seat ring and control sleeve)	Martensitic stainless steel if any one of the following applies: – The pressure difference across the valve is greater than 45 metres at any point in the designed operating regime. – The valve is used for flow regulation more often than once per month. – The system incorporates pump start up against the closed valve which is then opened under full pump shut off head. – The manufacturer recommends martensitic trim Austenitic stainless steel for less strenuous duties.	N/A
Handwheel	Cast iron or cast aluminium	Manufacturer's standard corrosion protection.
Fasteners	EN Grade 1.4401 (316)	N/A
External metal components	EN Grade 1.4401 (316)	N/A

13 Fabrication

Fabrication and welding of fabrications such as valve supports and guards shall comply with SPE-MM-0001.

14 Fasteners

All fasteners on the valve shall be of EN Grade 1.4401 (316), or higher corrosion resistance in the application.

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Flange fasteners shall be of hot dip galvanised steel.

Fasteners shall comply with SPE-MM-0001.

15 Spares

The spares which are to be provided are specified elsewhere.

16 Installation

The design of the pipework installation shall ensure that cavitation damage to the pipework does not occur.

Straight pipe shall be provided for at least four diameters upstream of the valve.

It is preferred that a straight pipe shall be provided for a distance of at least seven diameters downstream of the pipe. If the straight pipe is less than five diameters, special measures shall be designed to prevent damage to the pipework.

Downstream valves shall not be positioned closer than diameters downstream of the plunger valve.

Installation work shall comply with SPE-MM-0001.

17 Civil and Building Matters

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

18 Safety

The Contractor shall design and install all equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

The cage which shall be provided if the valve incorporates a weighted lever shall be designed to ensure that persons are not harmed by the weight raising or lowering unexpectedly.

19 Inspections

19.1 Workshop/Factory

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment and fabrications prior to despatch to Site and prior to payment being made.

Fabrications must be inspected by the Engineer after fabrication is complete but prior to corrosion protection.

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If the equipment is manufactured in the country, the Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site.

If the equipment is not manufactured in the country, the Contractor shall make all arrangements and carry all costs for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The inspection authorities' inspection shall include a full report on compliance of the equipment with the specifications and this report shall be submitted to the Engineer prior to dispatch from the manufacturer's works.

19.2 Site

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

19.3 Inspection During Defects Notification Period

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

20 Testing Requirements

20.1 Factory, etc.

The valve body shall be pressure tested to 1,5 times the valve's nominal pressure rating.

The valve seating shall be droptight tested to 1,0 times the pressure rating.

The Contractor shall submit reports for all specified factory tests to the Engineer prior to the equipment being transported to Site and prior to payment being made.

20.2 Site

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

(a) operation of all equipment.

(b) achievement of the specified performance requirements.

(c) correct operation of the control system.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

21 Documentation To Be Provided

The standard technical brochure giving the construction details and the dimensions of the valve shall be provided to the Engineer for review and acceptance.

The valve manufacturer's installation, operation and maintenance instructions for the correct equipment shall be provided in the Manual.

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SPECIFICATION: SPE-CC-001

CIVIL - FENCING

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1. SCOPE

1.1 SCOPE

This is a Particular Specification and covers the erection of new fences.

Where specified on the drawings, the fence type will be installed as per typical details included in the drawings set. A similar product may be presented to the Employer's Agent for approval. The fence will be a proprietary product and shall be installed according to the manufacturer's specifications and drawings. The contractor shall provide details of the proposed proprietary product they intend to use for approval by the Employer's Agent and architect. Installation must be done by a contractor or subcontractor that is approved by the fence manufacturer.

Interpretations and variations of this Specification are set out in the Specification Data.

2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following specifications, shall, inter alia, be applied together with this Specification:

a) Project Specifications;

b) SANS 1200 and applicable Amendments;

The construction details are presented on the Project Drawings.

2.2 DEFINITIONS

For the purposes of this Specifications the definitions and abbreviations given in the applicable Specifications listed in 2.1 shall apply.

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3. MATERIAL

3.1 POSTS, STAYS AND STANDARDS

Posts, stays and standards shall be of the type and size indicated on the Drawings. Posts shall include gate posts, straining posts, and corner posts.

Metal posts, stays and standards shall comply with the requirements of CKS 82 and SABS 280. "Acceptable" in CKS 82 means "acceptable to the Employer".

Tubular posts, standards and stays shall be galvanized in accordance with SABS ISO 1461:1999 Table 1 for type B articles. All rail and Y-sections shall be provided with a protective coating of tar or other approved material.

3.2 BOLTS FOR STAYS

Bolts shall be of mild steel and galvanized in accordance with SABS ISO 1461:1999 Table 1 for type C articles. The length and diameter of the bolts shall be as shown on the Drawings. All the necessary bolts, together with nuts and washers, shall be supplied with each post.

3.3 GATES

Gates shall comply with the requirements of CKS 146 and shall be manufactured to the dimensions shown on the Drawings or as per manufacturer's specifications where a proprietary product is used.

Gates shall be complete in every respect, and shall include hinges, washers, bolts, and the locking mechanism shown on the Drawings.

4. CONSTRUCTION

4.1 CLEARING OF FENCE LINE

Strip clearing for the fence shall be carried out in accordance with SABS 1200 C and will be measured and paid for under Section 1200 C of the Schedule of Quantities.

4.2 INSTALLING POSTS AND STANDARDS

Straining posts shall be erected at all ends, corners, and bends in the line of fencing and at all junctions with other fences. Straining posts shall not be spaced further apart than shown on the Drawings. The height of the posts above the ground shall be such that the correct clearance between the lowest wire and the ground can be obtained. Posts shall be accurately set in holes and, where indicated, shall be provided with concrete bases to the dimensions shown on the Drawings.

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Holes shall be dug to the full specified depth. Where, due to the presence of rock, the holes cannot be excavated by hand or by pneumatic tools and the Contractor has to resort to the use of explosives, he will be paid separately for the drilling and blasting operations required.

Corner, gate, end, and straining posts shall be braced by means of stays or anchors, as shown on the Drawings. Pipe stays shall be bolted to the posts. Gate posts shall not be used as straining posts, but at each gate post a straining post shall be placed as shown on the Drawings and stayed by means of an anchor consisting of six strands of wire.

Standards shall be firmly planted in the ground at the spacing shown on the Drawings or as directed by the Employer's Agent. The spacing of standards between any two straining posts shall be uniform. In rock or hard material standards shall either be driven or set in holes drilled into the rock. The size of drilled holes shall be such that a tight fit is obtained. Care shall be taken not to buckle or damage the standards when driven. Where indicated, standards shall be provided with concrete bases to the dimensions shown on the Drawings.

All posts and standards shall be accurately aligned and set plumb and shall be planted with the overhang as shown on the Drawings and at right angles to the direction of the fence. After posts and standards have been firmly set in accordance with the foregoing requirements, the fencing wire shall be attached thereto as described below.

4.3 CLOSING OPENINGS UNDER FENCES

At ditches, streams, drainage channels or other hollows where the fence cannot follow the general ground contour, the Contractor shall close the opening under the fence by means of horizontal barbed wires 150 mm apart and stretched between additional straining posts as shown on the Drawings. The opening shall be covered with strips of diamond mesh, 1 000 mm wide, fixed to the barbed wires.

In the case of larger streams, the opening below the lower fencing wire shall be closed by means of loose-hanging wire nets as shown on the Drawings. These nets shall be erected at streams only on the instructions of the Employer's Agent.

4.4 INSTALLING GATES

Gates shall be installed at the positions indicated on the Drawings or pointed out on Site. The gates shall be hung on gate fittings in accordance with the details shown on the Drawings or as per manufacturer's specifications. Gates installed on existing fences shall match the existing fence and gates. Gates shall be so erected that they swing in a horizontal plane at right angles to the gate posts and clear of the ground in all positions. Double swing gates shall close to have a gap of not more than 25 mm between them, and other gates shall close to be no further than 25 mm from the gate post.

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5. TOLERANCES

The completed fences shall be plumb, taut, true to line and to the ground contour, and with all posts, standards and stays firmly set.

The height of the lower fencing wire above the ground at posts and standards shall not vary by more than 25 mm from that shown on the Drawings. Other fencing wires shall not vary by more than 10 mm from their prescribed relative vertical positions.

Anchoring of a fence to structures shall be done as shown on the Drawings. The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or mesh so as to leave the fence with a neat and finished appearance.

6. MEASUREMENT AND PAYMENT

Item	Description	Unit
6.1.1	**Supply and install complete fencing panels to specification, including all required material, excavations, concrete, etc.:**	
	a) Type 1 - 2.4m High Wire Mesh Panel Fence	Unit: m
	b) Type 2 - 1.4m High Stock Fence	Unit: m

Item	Description	Unit
6.1.2	**Supply and install new gates:**	
	a) Type 1 - 8m wide x 2.4m High Motorised Security Gate	Unit: No
	b) Type 2 - 3m x 1.4m High double leaf gate (Heavy Duty W-Type farm gate)	Unit: No
	c) Type 1 - 8m wide x 1.4m High Motorised Gate	Prov Sum

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SPECIFICATION: SPE-CC-0002

CIVIL – DRY LAID CONCRETE BLOCK RETAINING WALL

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1. SCOPE

1.1 SCOPE

This is a Particular Specification and covers the construction of retaining structures by means of proprietary or custom-built precast concrete block retaining systems such as Löffelstein, Enviro-wall, Terraforce, etc.

2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following specifications, shall, inter alia, be applied together with this Specification:

a) Project Specifications;

b) SANS 1200 and applicable Amendments;

The construction details are presented on the Project Drawings.

2.2 DEFINITIONS

For the purposes of this Specifications the definitions and abbreviations given in the applicable Specifications listed in 2.1 shall apply.

3. MATERIAL

3.1 GENERAL

All materials used in constructing the retaining systems, as well as all precast units of proprietary or custom-built retaining systems shall be subject to the approval of the Employer's Agent.

When requested by the Employer's Agent, the contractor shall submit test certificates from an approved independent testing authority to show that the respective materials comply with the specified requirements, or certificates from the patent holders or licensees certifying that the manufactured items comply in all respects with the relevant product specifications.

3.2 CONCRETE BASES FOR EARTH RETAINING STRUCTURES

All materials for concrete bases for earth retaining systems shall comply with the relevant requirements of SABS 1200 G.

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3.3 PRECAST CONCRETE BLOCKS

The precast concrete blocks shall be of the type shown on the drawings or specified in the project specifications, or it shall be an approved alternative type. The blocks shall be uniform of colour and durable and shall not react with soil. All materials for precast concrete blocks shall comply with the relevant requirements of SABS 1200 GE.

3.4 BACKFILL MATERIAL

The backfill material shall be approved granular material, unless otherwise specified in the project specifications or on the drawings.

4. CONSTRUCTION

4.1 EXCAVATIONS

All excavations for the bases of the earth retaining systems shall be done in accordance with the provisions of SABS 1200 D. The contractor shall not commence with the construction of the bases before the excavations have been properly cleaned by the contractor and inspected and approved by the Employer's Agent.

4.2 BASES

The bases for the earth retaining systems shall be of the type or types shown on the drawings or specified in the project specifications.

The provisions of SABS 1200 G shall apply to the construction of concrete bases. The bases shall be constructed in accordance with the dimensions and levels shown on the drawings.

No precast concrete blocks shall be installed until the engineer has inspected and approved in writing the completed bases.

4.3 INSTALLING THE PRECAST CONCRETE BLOCKS

The precast concrete blocks shall be installed on the completed bases in accordance with the specifications of the patent holders or the licensees and in accordance with the lines, levels and angles of inclination shown on the drawings, or with the variations ordered in writing by the Employer's Agent.

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5. TOLERANCES

5.1 PATENT RIGHTS

The contractor shall negotiate directly with the patent holders or licensees in connection with royalties payable for the use of the patented systems. The contractor shall arrange for technical assistance by the patent holders or licensees before and during construction.

6. MEASUREMENT AND PAYMENT

Item	Description	Unit
6.1	**Patented earth retaining systems:**	
	(i) Löffelstein precast concrete blocks of type (State Type)	Unit: m^2
	(ii) Enviro-wall precast concrete blocks of type (State Type)	Unit: m^2
	(iii) Terraforce precast concrete blocks of type (State Type)	Unit: m^2
	(iv) Etc. for other patented earth retaining systems and other types of blocks	Unit: m^2

The unit of measurement shall be the square metre of the front vertical face of the earth retaining system placed in position as shown on the drawings. The front vertical face shall be measured from the top of the base to the top of the earth retaining system.

The tendered rate shall include full compensation for procuring, furnishing, transporting, handling, and placing all materials and precast concrete blocks, including the specified backfill material between the blocks, compacted fill and/or drainage material behind the blocks (20mm stone), Geotextile material as well as geogrids and any additional costs required for placing the blocks in position complete as specified.

Item	Description	Unit
6.2	**Excavation for concrete bases for earth retaining systems**	
	(i) In soft material	Unit: m3
	(ii) Extra over subitem (a) above for excavation in hard material	Unit: No
	(iii) Base preparation and compaction to minimum of 90% of modified AASHTO MDD	Unit: m^2

Item	Description	Unit
6.3	**Concrete bases for earth retaining systems**	
	(i) Class 20MPa/20 concrete footings including formwork and 80 kg/m^3 of reinforcement, to manufacture's detail	Unit: m^3

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SPECIFICATION: SPE-CC-0003

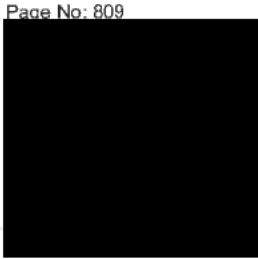
DESIGN, SELECTION AND INSTALLATION OF HDPE DAM LINERS

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1 SCOPE

This section deals with the supply and installation of an HDPE liner to seal and separate the ground water drainage system from the overlying leakage detection system.

The HDPE liner shall conform to the requirements of SANS 10409: 2020 with the additions and amendments contained within this specification. Where this specification conflicts with SANS 10409, the requirements of this specification shall be applicable. Where this spec conflicts with manufacturer's specification the latter shall be applicable.

2 INTERPRETATIONS

2.1 DEFINITIONS (SANS 10409, SUBCLAUSE 3)

Add in the following abbreviation:

HDPE: High density polyethylene

2.2 NORMATIVE REFERENCES

The following specification makes reference and amendments to SANS 10409:2020 and should be read in conjunction with it.

In addition, all manufacturer's specifications (transport, storage, installation and testing) shall be adhered to.

3 MATERIALS

3.1 USE OF THERMOPLASTICS GEOMEMBRANES IN PARTICULAR APPLICATIONS, AND SELECTION OF GEOMEMBRANE TYPE AND THICKNESS (SANS 10409, SUBCLAUSE 4.1)

The polyolefin products supplied for use as geomembranes shall comply with the Standards and tests as set out in SANS 10409:2020 as well as GRI Test Method GM13 (for HDPE products).

3.1.1 Thickness (SANS 10409, Subclause 4.3.2)

The nominal thickness of the HDPE geomembrane shall be 1.0 mm.

3.1.2 Width (SANS 10409, Subclause 4.3.4)

The nominal width of a seamless geomembrane shall be not less than 5.0 m.

3.1.3 Length (Subclause 4.3.4)

The nominal length of a geomembrane shall be not less than 100.0 m.

4 CONSTRUCTION

4.1 STRUCTURES WHICH PENETRATE THE LINING SYSTEM (SANS 10409, SUBCLAUSE 7.4)

4.1.1 Column footings

Details of anchoring the liner to the column footings which penetrate and extend below the concrete floor lining panels are shown on the drawings.

Attention is drawn to the importance of the construction sequence the contractor proposes to follow in order to allow for the mechanical fixing to the column bases as well as to prevent undue damage to the liner due to subsequent construction activities in constructing the overlying layer-works.

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4.1.2 Leakage detection pipes of 110 mm diameter

The perforated leakage detection pipes will be embedded in the no-fines concrete underlying the concrete lining slabs of the reservoir basin and slopes. These pipes will collect any leakage from the reservoir and discharge it into the subsurface galleries. The pipes will therefore have to penetrate through the HDPE liner, which is meant to isolate the leakage detection drainage system from the groundwater drainage system, thereby allowing for their independent capture of water and monitoring thereof.

The joint between the leakage detection pipe and the liner at the penetration must therefore be watertight. The leakage detection pipe will be solid (i.e. un-perforated) after the penetration of the HDPE liner, up to its termination in the subsurface gallery.

The proposed sealing method of the joint at the penetration is welding the liner to the solid HDPE pipe as indicated on the drawings. Alternative methods such as mechanical fixing with non-corrodible clamps to a "pipe boot" welded to the liner may be proposed by the Contractor if they can be proven to be of equivalent quality, durability and longevity.

4.2 ANCHORAGE SYSTEMS (SANS 10409, SUBCLAUSE 7.5)

4.2.1 Perimeter beam anchoring

Mechanical anchoring will be made to the perimeter of the reservoir. A perimeter mass concrete beam, located at the footing of the vertical reinforced concrete perimeter cantilever wall, is provided for the fixing and sealing of the perimeter. However, the contractor may not rely on this for anchoring during construction. Therefore, this does not relieve the contractor to make arrangements for weighing down the liner for preventing lifting of the liner due to winds as set out in the specifications.

4.2.2 Anchorage around column bases

Mechanical anchoring will be made to the perimeter of each reservoir column base in the basin, as noted in 4.1.1 above).

4.3 GEOMEMBRANE INSTALLATION (SANS 10409, SUBCLAUSE 9)

4.3.1 Earthworks

The HDPE liner shall be placed on top of the Sand Blanket filter zone, which shall comply with its relevant specifications and grading envelope as per SANS 1200DE and as amended. Notwithstanding, any protrusions above the finished levels shall be removed before providing the bedding layer and installing the liner.

4.4 GEOMEMBRANE FIELD SEAMING (SANS 10409, SUBCLAUSE 10)

4.4.1 Weather conditions

Details of inclement weather are included in the Contract Data.

Cognisance should be made of the hot weather months and related wrinkling and slack due to expansion. Cognisance should further be made of high wind speeds which could also be expected during the same hotter summer months, which could hamper installation. The liner should be installed during cooler and where possible overcast weather. The installed liner is to be prevented from lifting and tearing during strong winds by weighting with small bags or other suitable measures.

Manufacturer specifications and limitations shall be adhered to.

5 TESTING, SURVEYING IN AND MEASUREMENTS

5.1 CHECKLISTS, CERTIFICATES, ETC.

Certificates, checklists and forms as indicated under in SANS 10409:2020 Annexures A to I inclusive are to be completed upon completion of the various tasks to install the liner.

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6 MEASUREMENT AND PAYMENT

6.1 BASIC PRINCIPLES

The rates shall cover the cost of supplying the specified or scheduled items or systems, complete as indicated on the drawings, and as specified above. It shall include the cost of all fixings, connections, weighting down, installing/fixing, grouting/casting in, etc. unless otherwise scheduled. The rate shall further include for all procurement costs, transportation and handling requirements, all plant, labour and materials necessary for proper installation and operation. The cost of laps, welds and testing shall be deemed to be included in the unit rates of the scheduled items.

6.2 SUPPLY AND INSTALLATION OF HDPE LINERS ON BASIN FLOOR..... Unit: m^2

The rate shall cover the cost of the material, installation of the liner, trimming, the welding of panels, the weighting down of the liner as it is installed, and all other requirements as described in SANS 1526: 2015 (Edition 3) and SANS 10409 : 2020 (Edition 2).

6.3 SUPPLY AND INSTALLATION OF HDPE LINERS ON EMBANKMENT SLOPES..... Unit: m^2

The rate shall cover the cost of the material, installation of the liner, trimming, the welding of panels, the weighting down of the liner as it is installed, and all other requirements as described in SANS 1526: 2015 (Edition 3) and SANS 10409 : 2020 (Edition 2).

6.4 FIXING OF HDPE LINERS AGAINST CONCRETE SURFACES .....Unit: m

The fixing of the liner shall be measured by linear metre and shall cover the cost of all materials, drilling, grouting and fixing of anchors complete as per Drawing Nos. 1001757-2000-DRG-CC-2531 and 2525.

6.5 WELDING OF HDPE LINER TO THE PENETRATING 110 MM PIPES OF THE LEAKAGE DETECTION SYSTEM..... Unit: No

The penetration of the HDPE liner by the leakage detection pipes will be measured by number. The complete cost of supply of parts, labour, equipment, measuring, cutting, fitting, laps, welding and testing is deemed to be included in the rate. The cost of the pipes will be measured elsewhere.

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SPECIFICATION: SPE-GG-0001

GEOTECHNICAL - GEOSYNTHETICS

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1. SCOPE AND PURPOSE

1.1 SCOPE

This Particular Specification covers the various construction activities associated with geosynthetics in the construction of reinforced earth fill embankment which form part of this Contract.

This document is to be read in conjunction with the following specifications:

- C3.7.1: SANS 1200 Specifications
- C3.7.2: Amendments to the SANS1200 Specifications
- C3.7.5: Particular Specifications

This document serves as the particular specifications for geotechnical applications not covered by the SANS1200 specifications. This relates specifically to:

- Mechanically stabilised earth
- Geosynthetics

Work appurtenant to the construction of reinforced earth fills such as earthworks, testing, monitoring etc shall be carried out as specified in the appropriate Standardised Specifications and will be measured and paid for under those Specifications.

1.2 PURPOSE

The construction of a geosynthetic reinforced earth fill embankment is required due to the weak soft insitu materials, height of the earth fill required to support the reservoir structure, temporary crane loading to be placed on the earth fill embankment for construction of the reservoir as well as to mitigate excessive movements of the full system over time. Long term consolidation settlement is anticipated. No preloading has been undertaken to minimise the magnitude of long-term settlements on the overall contained reservoir structure.

To minimise differential settlement and to ensure bearing of the system and stability of the earth fill slopes, a geosynthetic reinforced system is to be constructed comprising of geogrids placed at specific locations within the earth fill (as per Project Drawings and Specifications). Structural fill is to be placed between the geogrid layers and for the construction of the earth fill. A bulk earthworks level is to be constructed onto which the earth fill bulk earthworks are placed and geogrids placed where specified. The geogrids and structural fill will be placed to achieve finished platform level. The bulk earthworks level shall be constructed by means of cut and fill as detailed on Project Drawings.

Included in this specification is the construction of the geosynthetic-reinforced earth fill embankment on to which the reservoir structural works will be placed. The geogrids are used to strengthen and reinforce the earth fill embankment over poor weak subgrade. This specification covers the supply and installation of geogrids used as reinforcement layers placed within structural fill.

The stability of the earth fill embankment during construction is governed by the strength and consolidation of the soft insitu materials. The placement of the earth fill lifts shall be undertaken within minimum defined time periods as detailed in Part C3 of the Tender documents to ensure stability of the embankment.

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2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following specifications, shall, inter alia, be applied together with this Specification:

a) Project Specifications

b) SANS 1200 and applicable Amendments

c) SANS 8006-1:2018 - Code of practice for strengthened/reinforced soils and others fills

d) BS EN 13251 : 2016 – Geotextiles and geotextile-related products - Characteristics required for use in earthworks, foundations and retaining structures

e) BS EN 14475 : 2006 – Execution of special geotechnical works – Reinforced fill.

f) COTO Chapter 12: Geotechnical applications, 12.11 Geosynthetics

The construction details are presented on the Project Drawings.

2.2 GEOTECHNICAL INVESTIGATION

Subsoil investigations have been carried out across the site and within the footprint of the reservoir structure and embankments. The results of the investigations are made available to the Contractor.

2.3 DEFINITIONS

The terms, definitions and symbols defined in COTO Chapter 12.11 Geosynthetics will be applicable.

2.4 DESIGN CONSIDERATIONS

Designs for the reinforced earth fill embankments have been compiled and relevant information will be issued to the Contractor prior to execution of the work. The Contractor must review all information provided and design details and if required, request additional information in writing prior to ordering of materials and establishment at the site.

The stability of the earth fill embankment during construction is governed by the strength and consolidation of the soft insitu materials. The placement of the earth fill lifts shall be undertaken within minimum defined time periods as detailed in Part C3 of the Tender Documents to ensure stability of the embankment. The access through the embankment to the reservoir structure for construction works shall be selected such that:

- the total and differential settlement of the constructed embankment does not impact the reservoir structure and placed embankment either side of the access point.
- the stability of the embankment is not compromised.
- The geotextile placement forms continuous stability for the reinforced earth fill embankment across embankment construction points.

The Engineer shall be called to inspect all prepared surfaces prior to applying the geotextiles.

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3. MATERIAL

3.1 GENERAL

All materials used in the works shall conform at least to the appropriate SABS or BS standards where such standards apply to geosynthetics, and/or as specified in the Contract Documentation and shall be subject to approval of the Engineer. The Contractor shall submit product certificates, conformance documentation related to the specifications, test results as required together with samples of materials and, where applicable, designs that he proposes to use in the construction of the works to the Engineer for his acceptance/approval as provided for in the Contract Documentation.

3.1.1 FILL

All bulk earthwork fills and structural fills shall be in accordance with the Project Specifications and Project drawings. The structural fill to be placed between the geogrids is specified in SANS1200 DE amendments and comprises minimum G7 material as detailed in SANS M with additional requirements in respect to grading and strength specified in SANS DE amendments. The grading specifications is required as per the design for drainage of the system. The G7 and G6 materials requirements are detailed in drawings as G6* and G7* to indicate the additional requirements for grading and strength as per SANS1200 DE.

3.1.2 GEOGRID

The geogrid shall be a synthetic polymer material manufactured in a continuous permeable homogeneous sheet (in rolls).

The synthetic polymer shall be one or more of the following:

- polyester
- polypropylene
- polyethylene.

Because of the temperature and moisture susceptibility of polyamide, this synthetic product is not considered acceptable.

The geogrid shall be used as flexible reinforcement for the earth fill embankment and comprise of planar structures consisting of a regular open network of woven, integrally connected tensile elements of yarn. The yarn is made from high-modulus polyester fibres of polyethyelene terephthalate (PET). The woven grid is coated with a protective layer of black polymer. The product is required to have a protective polymer coating and have high interactive flexibility to ensure the required bond between the fill material and the geogrid. The geogrids used in the design as per the design drawings are:

- Medium strength geogrid (Huesker FORTRAC R400/50-30 T or similar approved); and
- High strength geogrid (Huesker FORTRAC R800/50-30 T or similar approved).

The following specifications shall apply:

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TABLE GG-1

MEDIUM STRENGTH GEOGRID (**FORTRAC R400/50-30 T OR SIMILAR APPROVED**)				
Material		Regular open network of integrally connected tensile elements of yarn. The yarn is made from high-modulus polyvinyl alcohol (PVA) multifilament fibres in the machine direction (MD) and polypropylene (PP) fibres in the cross-machine direction (CMD). The product shall have a protective polymer coating.		
Nominal Tensile Strength	Machine Direction (MD)	kN/m	≥ 400	ISO 10319
	Strain at nominal tensile strength (%) (MD)	%	≤ 10 %	
	Cross Machine Direction (CMD)	kN/m	≥ 50	
	Strain at nominal tensile strength (%) (CMD)	%	≤ 10 %	
Flexural rigidity (MD)		mg-cm	3 170 000	ASTM D7748
Coefficient of interaction in sand (MD)			≥ 0.9 [-]	ISO 12957-1; DIN EN 13738; DIN 60009
Long Term design strength (LTDS*) (MD acc. BBA certificate for 120 years at 20°C in fill soil with $D_{90} \leq 50$ mm with $2 \leq pH \geq 12$, max. 1 month exposure and global safety concept)		kN/m	≥ 190	ISO 10319
Creep strain between 1hour and 120 years at 50% loading ratio (MD)		%	≤ 1 %	
Approximate mesh size	A (CMD) x B (MD) (average grid size)	mm	43 x 34	
	C (CMD) x D (MD) (average aperture size)	mm	30 x 25	
Roll Dimensions		m	5 x 100	ISO 12958
Nominal mass		g/m²	1200	ISO 9864

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TABLE GG-2

HIGH STRENGTH GEOGRID **(FORTRAC R800/100-30 T OR SIMILAR APPROVED)**				
Material		regular open network of integrally connected tensile elements of yarn. The yarn is made from high-modulus polyvinyl alcohol (PVA) multifilament fibres in the machine direction (MD) and polypropylene (PP) fibres in the cross-machine direction (CMD). The product shall have a protective polymer coating.		
Nominal Tensile Strength	Machine Direction (MD)	kN/m	≥ 800	ISO 10319
	Strain at nominal tensile strength (%) (MD)	%	≤ 10 %	
	Cross Machine Direction (CMD)	kN/m	≥ 100	
	Strain at nominal strength (%) (CMD)	%	≤ 10 %	
Flexural rigidity (MD)		mg-cm	3 170 000	ASTM D7748
Coefficient of interaction (MD)			≥ 0.9 [-]	ISO 12957-1
Long Term design strength (LTDS*) (MD acc. BBA certificate for 120 years at 20°C in fill soil with $D_{90} \leq 50$ mm with $2 \leq pH \geq 12$, max. 1 month exposure and global safety concept)		kN/m	≥ 360	ISO 10319
Creep strain between 1 hour and 120 years at 50% loading ratio (MD)		%	≤ 1 %	
Approximate mesh size	A (CMD) x B (MD) (average grid size)	mm	50 X 40	
	C (CMD) x D (MD) (average aperture size)	mm	26 X 30	
Roll Dimensions		m	5 x 100	ISO 12958
Nominal mass		g/m²	2400	ISO 9864

The long-term design strength shall be determined in accordance with BS 8006-1: 2010.

The service life in accordance with BS 8006-1:2010 for the reinforced soil embankment shall be 120 years. Partial factors as per BS 8006-1:2010 and per manufacturer's specifications should be used to obtain the minimum 120-year maximum design strengths prescribed in the design and indicated in Project Drawings.

3.1.3 QUALITY

Where there is a standardisation mark programme for any material, all such material supplied shall bear the official standardisation mark.

Alternative materials proposed by the Contractor shall be tested. The test, as well as the materials, shall be approved by the Engineer prior to any such materials being built into the works and all costs involved in testing shall be deemed to be included in the rates tendered.

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The tests to be carried out on geogrids, as indicated in Table GG-1 and Table GG-2, relate to the material and the method of manufacture and are used mainly to ascertain that the correct specification of geogrid is supplied, and that the material is equivalent in quality to that selected and specified for use on the Works. The Contractor will be required, at the request of the Engineer, to submit a certificate by an approved laboratory to prove compliance with the specified qualities without additional cost to the Employer.

4. CONSTRUCTION

4.1 INSTALLATION OF THE GEOGRIDS

The specified geogrids shall be installed as part of the bulk earthworks as detailed on the Project Drawings. The geogrids shall be installed in accordance with BS EN 14475: 2006, the Supplier installation guidelines and specifications and in accordance with the lines, levels and angles of inclination shown on the Project Drawings, or with the variations ordered in writing by the engineer.

A "smooth" bulk earthworks layer shall be constructed to minimise installation damage to the geogrid. The bulk earthworks level before placement of the geogrid defined as dressed subgrade is a levelled and compacted surface with removal of foreign material. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the subgrade dressed off parallel to the finished profile. If the subgrade comprises of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operations, an insulation layer of granular materials or over size brick aggregate not less than 10 cm thick of suitable thickness shall be provided for blanketing the sub-grade. After the pioneer layer is stable, localised areas will require infill with granular material prior to placement of the geogrid.

The geogrid shall be laid only where the underlying layer meets all the specified requirements and has been approved by the Engineer. Before the construction of the geogrid, the Contractor shall check the underlying layer to establish whether there is any damage, wet spots or other defects, which shall be rectified in accordance with the instructions of the Engineer before the geogrid is constructed.

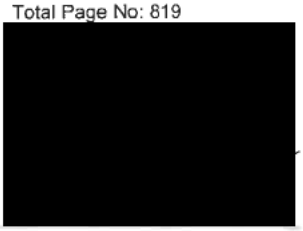
The geogrid shall be laid across the width of the embankment in accordance with area marked on Project Drawings and tensioned free of kinks, folds and edge deviations exceeding 500mm. The cut-to-length geogrid is laid horizontally and with the main direction of tension (machine direction) perpendicular to the embankment front. Particular attention shall be paid to ensure the sheets are installed with the correct orientation.

No overlapping of sheets is allowed in the main direction of tension without design verification. Adjoining layers of geogrid shall overlap in their length (side overlap) by a minimum overlap exceeding 100mm. Parallel rolls shall be overlapped, sewn or joined in accordance with Supplier specifications. Sewn seams if required shall meet the same tensile strength as required for the geotextile itself.

The geogrids shall not be driven directly over. A minimum soil cover of 200mm should first be provided. Before any interruption to works, all installed geogrids should be covered over with fill.

The fill material is placed and compacted in layers up to the required layer thickness as per Project Drawings. The fill should be placed a distance of between 250mm to 500mm beyond the geogrid and embankment front to allow the slope surface to be smoothed after

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completion of the embankment without damaging the reinforcement. Compaction shall be undertaken from the front of the slope to the rear. Once the full construction height is achieved, the slope may be required to be levelled and compacted.

Note: Dependent on the Contractor's construction method, access through the embankment may need to be constructed. This could result in the embankment being constructed in sections. Where an access road through the embankment is provided, additional reinforcement geogrids may need to be provided and installed on the internal side slopes either side of the access road to guarantee stability of the embankment during the construction period. The additional geogrids required are dependent on the temporary internal side slopes. The tension direction for the geogrids for the embankment are parallel to the internal side slope front and additional geogrids may be required to be installed with the tension direction perpendicular to the temporary internal side slope front. Erosion protection of the internal side slopes shall be provided during construction.

5. TOLERANCES

Level and layer thickness tolerances as detailed in Standard SABS 1200 specification and this Project's applicable contract documentation.

6. QUALITY OF MATERIALS AND WORKMANSHIP

6.1 MATERIALS

The quality and workmanship for the construction of the geogrids shall be determined as follows as a minimum. The Engineer shall conduct routine inspections and tests to ensure the minimum requirements are achieved as detailed below, in Table GG-1 and Table GG-2 and in accordance with Standard SABS 1200 and this Project's applicable contract documentation. The Contactor shall provide for approval by the Engineer a quality control system that includes the criteria below demonstrating hold points for inspection before construction works can proceed.

The minimum criteria for the construction of the geogrid shall be applied as follow:

1) Verify that foundation soil on bulk earthworks level meets minimum strength and preparation requirements. Levels, lines and inclination to be checked in accordance with Project Drawings, Standard SABS 1200 and this Project's applicable contract documentation.

   Hold point: Inspection and approval required before installation of geogrids can be installed.

2) Verify correct geogrid product is delivered for installation. Engineer to undertake a spot check of products (this shall check dimensions of product, label etc).

3) Verify geogrid is installed correctly as per Section 4. The following shall be checked:

   (i) Verify geogrid installed and tensioned free of kinks, folds and edge deviations exceeding 500mm.

   (ii) Verify that adjoining layers of geogrid overlap in their length by a minimum overlap exceeding 100mm.

   Hold point: Inspection and approval required before installation of fill layer can be installed

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4) Verify correct installation of fill material in accordance with Standard SANS 1200 and this project's applicable contract documentation.

In-situ testing may be required dependent on conditions on site. These shall be as advised by the Engineer if required.

7. MEASUREMENT AND PAYMENT

Item	Description	Unit
GG-1.1	**Medium strength geogrid (Huesker FORTRAC R400/50-30 T or similar approved)**	**square metre (m²)**

The unit of measurements shall be the square metre of area covered with approved geogrid placed in position.

The tendered rate shall include full compensation for the supplying, cutting, waste, placing, joining, overlapping, protecting and securing the material in position. The tendered rate shall include full compensation for the labour, plant and equipment required for the operation. The tendered rate shall include required testing as well as the preparation of the fill surface for receiving the geotextiles.

Item	Description	Unit
GG-1.2	**High strength geogrid (Huesker FORTRAC R800/100-30 T or similar approved)**	**square metre (m²)**

The unit of measurements shall be the square metre of area covered with approved geotextile placed in position.

The tendered rate shall include full compensation for the supplying, cutting, waste, placing, joining, overlapping, protecting and securing the material in position. The tendered rate shall include full compensation for the labour, plant and equipment required for the operation. The tendered rate shall include required testing as well as the preparation of the fill surface for receiving geotextiles.

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SPECIFICATION: SPE-GG-0002

GEOTECHNICAL – SOIL NAILS

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1. SCOPE AND PURPOSE

1.1 SCOPE

This specification applies to the supply of materials and construction of soil nailed excavations and slopes.

The materials used and the installation procedure to install dowels in a rock mass is similar to that of soil nails. This specification is therefore also applicable to the installation of dowels.

1.2 PURPOSE

Temporary lateral support is required for the construction of the reservoir structure and is detailed as per the Contract Documentation and as detailed in the construction drawings. The final finished cut and fill section is required for stability of the reservoir in operation.

1.3 SPECIAL REQUIREMENTS

When executing sprayed concrete, the relevant national standards, specifications or statutory requirements shall be observed regarding:

- Environmental constraints and regulation
- Security of the site
- Safety of the working procedures
- Operational safety of plant and auxiliary plant, equipment and tools.

2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following specifications, shall, inter alia, be applied together with this Specification:

a) Project Specifications

b) SANS 920 – Steel bars for concrete reinforcement

c) SANS 1024 – Welded steel fabric for concrete reinforcement

d) SAICE Lateral Support in Surface Excavations: Code of Practice 1989

e) BS EN 14490:2010. Execution of special geotechnical works- Soil nailing

f) COTO Chapter 12: Geotechnical applications,

The construction details are presented on the Project Drawings.

2.2 GEOTECHNICAL INVESTIGATION

Subsoil investigations have been carried out across the site and within the footprint of the reservoir structure and embankments. The results of the investigations are available to the Contractor.

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2.3 DEFINITIONS

Soil Nail - is a generic term covering steel bars and/or polymeric rods in soil which are fully bonded but generally not tensioned.

Rockbolt - is a generic term covering all types of steel bars and/or polymeric rods in rock which are partially or fully bonded and tensioned.

Bolting - describes the drilling of holes by means of percussion or hydraulic equipment in rock and the subsequent insertion and grouting or mechanical anchoring of steel bars within these holes. Face plates, washers/spacers and nuts are generally secured to the protruding end of the bolts which are provided with a thread.

Soil Nailing - as for bolting but inserted into soil and/or highly/completely weathered or friable rock.

2.4 DESIGN CONSIDERATIONS

Designs for the soil nails and dowels sections have been compiled and relevant information will be issued prior to execution of the work. All information provided and design details must be reviewed and if required, request additional information in writing prior to ordering of materials and establishment at the site.

If the site conditions are different from that detailed in the design reports, e.g. composition and thickness of ground and rock horizons, ground water tables, etc., the geotechnical design engineer shall be notified immediately to allow verification of the soil nail or rock dowel designs.

3. MATERIAL

3.1 SOIL NAIL AND ROCK DOWEL

All materials used for rockbolt, dowels and soil nails shall comply with the following standards:

SANS 920 – Steel bars for concrete reinforcement

SANS 1024 – Welded steel fabric for concrete reinforcement

SAICE Lateral Support in Surface Excavations: Code of Practice 1989

BS EN 14490:2010. Execution of special geotechnical works- Soil nailing

These shall be steel bars and/or polymeric rods, either solid or hollow stem. The steel bars shall be hot-rolled, deformed, continuously coarse-threaded high-yield steel (greater than 500MPa) of specified diameter and length. Steel for hollow-stem self-drilling anchors shall also comply with EN 10210 (Hot finished structural hollow sections of non-alloy and fine grain structural steels) and SANS 920.

Polymeric rock bolts and dowels may be used as specified in the Contract Documentation. Mechanically end-anchored rockbolts and dowels shall be permitted, including 'split set', 'swellex' and other types.

Steel faceplates, hemispherical washers and nuts shall be supplied with each soil nail. All soil nails and face plates, nuts and washers shall be hot dip galvanised in accordance with SANS 121/ISO1461 to a mean coating thickness of 85µm. The soil nails, face plates, nuts

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and washers shall thereafter be passivated using a non-toxic approved product. When used in conjunction with wire netting, galvanised spike plates may be specified.

Soil nails and dowels shall have non-corrodible centralizers capable of ensuring an even annulus of grout around the steel bar. The nominal diameter of the centralizers shall not differ from the specified diameter of the drill hole by more than 10mm.

3.2 GROUT

Grout shall generally consist of a suitable mixture of cementitious material and water and plasticizers, if required. No lumps shall be permitted in the grout mixture.

Grout should achieve a minimum characteristic strength of 20MPa prior to load being applied in the soil nails or dowels. The 28 days characteristic strength of the grout mix should not be less than 30MPa. The water cement ratio of the grout shall not exceed 0.45.

Only CEM I 42.5 N / CEM II 35.2.N.BV which complies with the requirements of SANS 50197 shall be used unless otherwise specified in the Contract Documentation. Where site blends are proposed, they shall conform to the requirements of SANS 50197 - 1.

Fine aggregate if used in the mix shall consist of siliceous granules, finely ground limestone or very fine sand. It shall all pass a 0,600mm sieve and shall be subject to the approval of the Engineer. The aggregate content in the grout shall not exceed 30% of the mass of the cement.

Admixtures shall not be used in the grout without the approval of the Engineer. Admixtures shall be free of any product liable to damage the steel or the grout itself, such as halides, nitrates, sulphides, sulphates, etc. The amount of admixture to be used shall be in accordance with the manufacturer's instructions.

The mixed grout shall have the following properties:

a) C1-ions content shall not exceed 750mg per litre.

b) Viscosity will be measured in a standard flow cone or similar approved. Flow shall not be less than 12 seconds and not more than 30 seconds. Any other approved cone shall be calibrated against the standard cone.

c) Bleeding at 20°C shall not exceed 2 % by volume, 3 hours after mixing, and the maximum bleeding shall not exceed 4 %. After the initial grouting of the nails, any bleed shall be compensated for by topping up the hole.

d) The compressive strength of 100mm cubes made of the grout and cured in a moist atmosphere for the first 24 hours and thereafter in water at 20°C shall exceed 20MPa at 7 days.

e) Grout must be tested on a daily basis.

Water used for batching of grout shall be potable, complying with SANS 51008.

3.3 QUALITY

Where there is a standardisation mark programme for any material, all such material supplied shall bear the official standardisation mark.

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[redacted]

Alternative materials or equipment proposed by the Contractor shall be tested. The test, as well as the materials or equipment, shall be approved by the Engineer prior to any such materials or equipment being built into the works and all costs involved in testing shall be deemed to be included in the rates tendered.

4. CONSTRUCTION EQUIPMENT

The Contractor shall not use equipment of which full details have not been submitted to the Engineer for approval. Details shall be submitted at least one month prior to the start of the activities.

4.1 DRILLING EQUIPMENT

The drill rig and equipment shall be in good working order and capable of producing the anchor/bolt or soil nail hole to the required dimensions, tolerances, direction and inclination without undue disturbance of the surrounding material. Should the type of rig and/or equipment prove inappropriate for the requirements or conditions on site, these shall be replaced by suitable equipment at the Contractor's cost. The drill rig/equipment shall be able to install and remove casings as required during drilling operations, without loss of direction or inclination, in all materials.

4.2 GROUT MIXER

The mixer used for the manufacture of grout for anchoring purposes shall be a high shear colloidal mixer. The holding tank shall be fitted with an agitator capable of maintaining the colloidal condition and fluidity of the mix. The outlet shall be fitted with a suitable filter with openings of less than 1,0mm to remove any aggregations.

4.3 GROUT PUMP

The grout pump shall be a positive-displacement type and shall, unless otherwise specified, be capable of exerting a constant pressure of at least 20bar or as may be required for high pressure grouting. The pump shall be fitted with a currently calibrated pressure gauge with a dial of a suitable diameter enabling accurate readings to the nearest bar and a valve which can be locked-off without pressure loss. The hoses used shall be appropriately rated for the pressures required.

5. EXECUTION OF THE WORKS

5.1 GENERAL

Soil nailing shall be further undertaken with special reference to BS EN 14490:2010.

Rockbolts or soil nails or mechanical earth anchors of varying length shall be placed at orientations on the excavation face or on other locations to provide support requirements. Spacing may be random; patterned or inserted as spot bolts / nails. Bolt / nail length; spacing; diameter; strength and protection against corrosion shall be as specified. The Engineer shall be accorded access to the bolting/ nailing position; to assess the stability of the cut face or natural slope. The Engineer shall indicate the number, sequence, precise

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location, length and orientation of bolts required, and may increase or decrease the number as necessary.

Soil nails or rock bolts shall be installed immediately as part of the excavation cycle at intervals specified by the Engineer to ensure its stability and to limit defamations as the excavations advances and be complete and approved before the ensuing excavation advance may commence, unless otherwise instructed by the Engineer in writing.

Dust pollution shall be minimised by means of pre-damping of materials, additional ventilation, water sprays, and maintaining equipment in good order.

5.2 TRIALS

The Contractor shall provide the Engineer with a method statement for the installation of test soil nails/ rockbolts. The Contractor shall carry out comprehensive trials to the satisfaction of the Engineer at least four weeks prior to the commencement of any permanent rock bolting / soil nailing.

Rock bolt / soil nail pull out tests will also be undertaken on the test bolts/nails in accordance with specifications. Changes as necessitated by the outcomes of these tests, shall be made to the method statement which shall be submitted to the Engineer for approval four weeks before being allowed to proceed with production work. Trials which are unsuccessful and/or which in the opinion of the Engineer do not meet the requirements of the specification will not be measured or paid for.

5.3 INSPECTION BY THE ENGINEER

The Contractor shall provide suitable plant, equipment and training, together with a competent operator to ensure safe and appropriate access for the Engineer right up to any part of the site requiring stabilisation to undertake whatever, observations, measurements or samples that may be required. No work which could pose a hazard to or disrupt these specialist inspections shall be undertaken by the Contractor on or near the area under inspection for the full duration of the inspection.

Notwithstanding the Contractor's previous finishing efforts, the Engineer will determine the final positions of rock bolts or soil nails required as well identify all blocks or wedges of rock or boulders or any other protuberances which require removal or stabilisation. The Engineer will confirm the final number, location, length, and orientation of each rock bolt / soil nail within two working days of inspecting a works zone.

5.4 DRILLING

a) General

The drilling methods for the installation of nails or bolts may either be by rotary, percussive, rotary-percussive, augering or vibratory methods, with or without using temporary casing and shall be chosen to ensure the minimum possible disturbance to the surrounding ground and a stable hole which will facilitate the insertion and grouting of the soil nails or rock bolts to the required tolerances and specification. Unless otherwise specified or instructed by the Engineer, the selection of method shall be entirely at the Contractor's risk. Should the selected method result in unstable holes or prevent efficient execution of work which does not meet the requirements of these specifications, the Engineer may instruct the Contractor to stop work and the Contractor shall adopt alternative drilling

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methods. No additional payment shall be made in this regard other than provided in the pricing schedule. No standing time or extensions of time shall be granted.

The use of drilling fluid shall not adversely affect ground conditions. Special care shall be taken when drilling into artesian ground water.

Work must immediately stop should conditions other than indicated in the Contract Documentation be encountered and the Engineer informed. Works shall only proceed on instruction of the Engineer.

b) Drilling requirements

Holes for rock bolts / soil nails shall be drilled to a diameter at least 25mm greater than the nominal diameter of the bolt/ nail. To avoid excessive deviation particular care will be required when advancing the hole.

After each hole is drilled to its full length and flushed via compressed air and/or water to remove all loose materials, it shall be probed to ensure collapse has not occurred and that it is clean over its full length. Thereafter the hole shall immediately be plugged to prevent debris from entering.

Where a hole is lost or abandoned due to mechanical breakdowns, failures or any other causes arising from the Contractor's omission to protect the works, a new hole shall be drilled, entirely at the Contractor's cost.

5.5 BOLT / NAIL INSERTION

The bolts are to be fitted with centralisers or a spirally wound grout tube providing the specified cover less than 1,5m spacing/pitch, homed and grouted to the collar as specified. A minimum of two centralisers are required for bolts less than 2,0m, with a centraliser 300mm from the proximal and distal ends. The bolt must protrude or be trimmed sufficiently for the application envisaged.

Mechanically end-anchored expansion shell rockbolts shall comprise a screwed end tapered cone with an internal thread and a pair of wedges secured by a bail. The full assemblage is inserted into a pre-drilled hole, 100mm longer than the bolt, to ensure the bail is not dislodged when forced against the end of the pre-drilled hole.

Split-set bolts are inserted into pre-drilled holes of diameter less than bolt Ø to ensure frictional anchorage along its entire length via the radial force generated through compression of the C-shaped tube.

Swellex dowels, folded during manufacture, are activated after insertion into a predrilled hole, by injection of high pressure (greater than 30MPa) water discharge.

Corrosion-resistant coatings are mandatory for both split-set and proprietary expandable folded tube rockbolts and dowels.

5.6 GROUTING

All rock bolts / soil nails shall be grouted to the collar of the hole, either by way of cement grout with or without additives or using cement or resin cartridges as approved by the Engineer. The Contractor shall ensure that whatever method is used, the grout cover to the bolts / nails is continuous and completely fills the annulus between the bolts and rock or soil. Special precaution is required to inhibit bleed and shrinkage of cement grouts.

All cartridge grouts must be sufficiently mixed to ensure required homogeneity.

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m) Method of grouting and details of grouting equipment,

n) Details of equipment for measuring the volume of grout injected into each drill hole together with the accuracy and method of calibrating the equipment,

o) Details of equipment for testing soil nails and dowels, including test and calibration certificates,

p) details of testing assembly including details of datum for deformation measurement and bearing pad, and

q) other construction related issues.

5.10 RECORDS

Records of lateral support installation will comply with the requirements of Section 10 of BS EN 14490:2010.

A construction and nail and dowel installation plan shall be prepared and shall be available on site containing the technical specification related to the nail and dowel system to be used and shall contain the following information:

a) Nail/dowel type with designation

b) Number of nails/dowels

c) Location, orientation and inclination of each nail/dowel and tolerances in position, to an agreed datum

d) Required load carrying capacity of the nail/dowel

e) Installation technique

f) Known obstructions and any other constraints on nail/dowel activities

g) Method of corrosion protection

h) Nail/dowel testing undertaken

i) Schedule of work.

An execution record shall be kept and shall include the following:

a) Project/element;

b) Nail/dowel designation;

c) Installation date;

d) Nail/dowel type, diameter, length, orientation;

e) Installation method;

f) Drilling method;

g) Borehole cased or not cased;

h) Borehole diameter;

i) Flush method;

j) Brief description of the soil or rock conditions

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If for any reason, grouting is interrupted and/or the installation of the bolts is delayed, the bolt shall be removed timeously from the hole before hardening. The grout shall then be removed by flushing or re-drilling and the bolt re-installed.

Grout shall be injected at the distal end of the hole, through appropriate tubes. Injection shall be continuous until flow occurs from the collar.

5.7 ROCKBOLT HEAD PROTECTION

After rock bolts / soil nails are installed successfully, grouted, tensioned where required, and approved by the Engineer, the bolt head shall be trimmed as specified.

5.8 MIX DESIGN

The Contractor shall submit details of the proposed grout mix proportions prior to commencement of soil nailing activities for approval by the Engineer.

5.9 METHOD STATEMENT

The Contractor must compile a method statement for the installation of the lateral support measures, inclusive of excavations, installation of the soil nails and dowels, application of the mesh reinforced sprayed concrete and drainage measures.

The method statement must be based on the requirements of Section 8 of BS EN 14490:2010, inclusive of the following:

a) Details of and assembled component samples comprising of soil nail or dowel bars, corrugated sheathing, coupling sleeves, nuts, washers, plates, connectors, centralizers, grout pipes and plugs capable of sealing the drill holes during grouting,

b) Details of galvanizing of steel components and method of making good any damaged galvanized coating,

c) Details of heat-shrinkable sleeve for protecting the connections between reinforcement bars if hot-dip galvanized coating to either the threads inside connectors or at the ends of reinforcement bars is not applied, together with details of the heat application equipment for shrinking the sleeves; risk assessment for using the heat application equipment and safety measures applicable to the use of the heat application equipment,

d) Method of repairing damaged heat shrinkable sleeves during heat application or other installation process of soil nails and dowels,

e) Details of corrosion protection for the threaded portion of the steel bar at soil nail or rock dowel head,

f) Details of working platforms required for the installation of nails or dowels,

g) Details of temporary support to drill holes,

h) Details of permanent casing that may be required in collapsing holes,

i) Method of storing materials,

j) Method of drilling and details of drilling equipment,

k) Method of assembling soil nail and dowel bars,

l) Method of installing soil nail and dowel bars into drill holes,

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k) Hydro-geologic conditions

l) Grout consumption

m) Other remarks (climate, weather and temperature);

n) Special measures, if any

o) Test results (if performed) and actions taken (if any).

6. WORKMANSHIP

6.1 TOLERANCES

The tolerances provided below shall be maximum permissible deviations from specified dimensions, levels, alignment, positions, etc., as shown on drawings.

a) Diameter of hole: + 10mm and – 5,0mm,

b) Position of hole: less than 75mm from specified position,

c) Alignment: less than 2,5% of specified inclination,

d) The length of drill hole will be 250mm more than the specified hole length.

6.2 ACCEPTANCE CRITERIA

The onus rests with the Contractor to produce work and products which comply with the characteristics and requirements of the specifications and drawings in all respects. The Contractor shall institute a quality management system and provide experienced engineers, technicians, foremen, inspectors and other technical staff, under the control of a designated quality manager, to give effect to and manage the quality management system.

Where any performance-based specifications apply, the Contractor shall institute a quality management system that will ensure and demonstrate that the required performance standards have been met and, where applicable, will continue to be met for any period which has been specified in the Contract Documentation.

The quality management system shall outline the minimum requirements and actions to be taken during the construction of all elements of the Works and shall include monitoring of the various properties of the elements of the Works using either a fully ISO certified quality assurance system or an appropriate quality management system based on recognised sampling and testing principles.

The Contractor shall carry out testing and measurement in accordance with the requirements specified in the Contractor's quality management system to confirm the conformance of the Works with all the relevant requirements and specifications. Although it is not a requirement for the Contractor to conduct regular tests and measurements on commercially produced products bearing the SANS, or any other internationally recognised, specification for products.

All measurements and test results shall be submitted, without delay, to the Engineer on the completion of each element of the Works. Should the sampling, testing and measurements for any end product be carried out by the accredited laboratory or institution, and prove compliance with the specifications, the Engineer may accept these

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results for acceptance control purposes at the cost of the Employer. In the event of method specifications being applicable for the construction of certain layers, products or elements, the Contractor shall follow the proposed methodology given in a method statement that has been commented on and/or accepted by the Engineer. Where applicable the methodology to be used and the acceptability of the work / product shall be demonstrated by means of an appropriate trial section carried out by the Contractor. Any subsequent deviation from the proposed methodology shall be submitted to the Engineer for comment prior to implementation.

All completed elements of the Works shall be submitted to the Engineer for written acceptance and the Contractor shall not cover up any completed work prior to such acceptance being issued. The Contractor shall plan, and make arrangements for, the submission of work for acceptance control in a manner which will afford the Engineer a reasonable and timeous opportunity for inspection, testing and measurement of the Works.

The Contactor shall agree all the process control sampling, testing, measurement and approval processes with the Engineer for each element of the Works before commencing work. Regardless of the acceptance of any materials or products based on the Contractor's process control the Contractor shall remain fully responsible for any defective material, product or plant/equipment used in the temporary and permanent Works.

Regardless of the Employer's quality control acceptance of any materials or products the Contractor shall remain fully responsible for any defective material, product or plant/equipment used in the temporary and permanent Works.

7. MEASUREMENT AND PAYMENT

c) Preamble

The tendered rate for each pay item shall include full compensation for providing, operating, maintaining, and decommissioning upon completion, of all the construction equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the pay item as specified, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

d) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as the Contractor deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.

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3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.

e) Items specifically for this Section of the specification

Item	Description	Unit
SN1	Establishment on site	lump sum

The tendered lump sum shall include full compensation for generally levelling the drilling site to the required post construction levels (where applicable), establishing on site with and subsequent removal of all structural platforms, rafts and all special plant and equipment for drilling and for carrying out operations, the cost of which does not vary with the actual amount of drilling done.

No additional payment will be made for the establishment of other or supplementary plant and ancillary equipment should that initially established by the Contractor be incapable of penetrating the subsurface soil or rock formations, or achieving the desired hole formation without undue disturbance of the surrounding material, or achieving the required production rate.

This work will be paid by lump sum: 50% payable when all equipment for the works is on site and the first hole has been drilled. The next 25% of the lump sum will be payable after half the total number of holes have been drilled, and the final 25% after all the holes have been drilled and the equipment has been removed from the site.

Item	Description	Unit
SN2	Move to and set up at each rockbolt, dowel or soil nail position	number (No)

The unit of measurement shall be the number of set ups as instructed and approved by the Engineer.

Item	Description	Unit
SN3	Install, grout and protect soil nails or rock bolts/dowels (lengths indicated)	number (No)

The unit of measurement shall be the number of rock bolts / soil nails installed as specified and as approved by the Engineer.

The tendered rate shall include full compensation for drilling, cleaning drill holes, procuring, corrosion protection, installing and seating rock bolts with all ancillary face plates, washers and nuts, grouting, protection of bolt ends and face plates, testing bolts as required, all labour, materials and all other incidentals required to complete the work in accordance with the Contract Documentation and the Engineer's instructions. All pull out test requirements and costs are deemed to have been included in this payment item and no extra payment will be made in this regard.

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Item	Description	Unit
SN4	Extra over for tensioning soil nails or rock bolts/dowels	number (No)

The tendered rate shall include full compensation for labour, plant, equipment, materials and all other incidentals required to complete the work in accordance with the Contract Documentation and as instructed by the Engineer.

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SPECIFICATION: SPE-GG-0003

GEOTECHNICAL - SHOTCRETE

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1. SCOPE AND PURPOSE

1.1 SCOPE

This specification applies to the manufacture and application of pneumatically applied sprayed concrete (also referred to as "shotcrete").

The work shall consist of furnishing, mixing, applying and curing sprayed concrete. The sprayed concrete will comprise of ordinary Portland cement and fine aggregate.

1.2 SPECIAL REQUIREMENTS

When executing sprayed concrete, the relevant national standards, specifications or statutory requirements shall be observed regarding:

- Environmental constraints and regulation;
- Security of the site;
- Safety of the working procedures;
- Operational safety of plant and auxiliary plant, equipment and tools.

2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following specifications, shall, inter alia, be applied together with this Specification:

a) Project Specifications

b) ACI 506.2-13 (Specification for "shotcrete", including reference to standards for cement, aggregate, water, admixtures etc.)

c) BS EN 14488-2:2006: Testing sprayed concrete.

d) COTO Chapter 12: Geotechnical applications, 12.5 Sprayed Concrete

The construction details are presented on the Project Drawings.

2.2 GEOTECHNICAL INVESTIGATION

Subsoil investigations have been carried out across the site and within the footprint of the reservoir structure and embankments. The results of the investigations are made available to the Contractor.

2.3 DEFINITIONS

Shotcrete - means mortar or concrete which can be pneumatically projected at high velocity onto a surface.

Shotcreting - is the process whereby mortar or concrete is pneumatically projected at high velocity onto a surface. It can comprise the application of dry-mix or wet-mix shotcrete.

Dry-mix shotcrete - constituent materials, comprising of a mixture of cementitious binder and aggregates, are mixed and delivered to the application nozzle in dry form. Water and admixtures are added at the application nozzle under high pressure while being sprayed onto the receiving surface.

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Wet-mix shotcrete - constituent materials, comprising of a mixture of cementitious binder, aggregates, water and admixtures, are premixed and delivered to the application nozzle as a wet-mix before being sprayed onto the receiving surface.

Dental Shotcrete - is shotcrete applied to fill/cover or repair of a specific area/feature.

2.4 DESIGN CONSIDERATIONS

Designs for the shotcreted sections have been compiled and relevant information will be issued to the Contractor prior to execution of the work. The Contractor must review all information provided and design details and if required, request additional information in writing prior to ordering of materials and establishment at the site.

3. MATERIAL

3.1 CEMENTITIOUS MATERIAL

a) Cement

Cement shall be CEM I or CEM II with a strength class of 42,5 or greater. Where site blends are proposed, they shall conform to the requirements of SANS 50197 - 1.

b) Supplementary cementitious materials

Additional supplementary cementitious materials may be added at the batchplant and used to replace specific proportions of the cementitious binder. The maximum supplementary cementitious material replacement values shall be cumulative, comprising proportions both pre-blended into the cement and supplementary cementitious materials added at the batchplant. The further blending of cements that contain a factory-blended proportion of supplementary cementitious materials exceeding 5% by mass of cement, except in the particular case of limestone, with supplementary cementitious materials of a different generic type or nature, e.g. site-based ternary blending, shall not be permitted. The site blending of CEM III/B, CEM III/C, CEM IV/B and CEM V cements with supplementary cementitious materials shall not be permitted.

Supplementary cementitious materials added at the site batchplant shall be classified and conform to the following requirements:

(i) Ground granulated blastfurnace slag or ground granulated corex slag, conforming to SANS 55167-1, up to maximum cumulative replacement value of 65% by mass of cementitious binder;

(ii) Fly ash, conforming to SANS 50450-1, up to maximum cumulative replacement value of 40% by mass of cementitious binder;

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(iii) Silica fume, conforming to SANS 53263-1, up to maximum cumulative replacement value of 10% by mass of cementitious binder; or

(iv) Other supplementary cementitious materials, blends of supplementary cementitious materials, and appropriate proportions thereof, shall be generally accepted by the construction industry and approved by the Engineer for use in concrete on the basis of published, comprehensive long-term research including in-field performance tests conducted over a minimum period of 10 years in a range of typical African exposure environments.

Separate storage facilities shall be provided on the site for each type of cementitious material used.

3.2 AGGREGATES

Aggregate shall conform to the requirements of SANS 1083, as well as the following:

(i) The fineness modulus of the fine aggregate as determined by SANS 3001-PR5 shall not vary by more than ± 0,2 from the approved modulus.

(ii) The sand equivalent of the fine aggregate shall be determined in accordance with SANS 3001-AG5 and shall be minimum 65%. The sand equivalent shall be considered as an indicator test, together with the clay content and methylene blue absorption value, where non-compliance may be established. The performance of aggregates in shotcrete shall be evaluated by drying-shrinkage tests in accordance with SANS-AG-33 (SANS 5836); and

(iii) Tests for organic impurities in natural sands shall be determined in accordance with SANS 5832 and shall be not darker than the reference solution.

3.3 WATER

Water used for batching of shotcrete shall be potable, complying with SANS 51008. The supply of water to the mixing nozzle shall be such that a pressure of at least 400kPa can be maintained.

3.4 ADDITIVES

Additives can comprise:

- superplasticizers to assist with the pumping of the shotcrete and
- setting accelerators which can be added during the application of shotcrete to accelerate the setting of the concrete.

Shotcrete admixtures shall comply with SANS 50934 and details of the admixtures shall be submitted to the Engineer together with the proposed mix design for approval prior to commencement of work. Admixtures shall have no deleterious effects on reinforcement or shotcrete, and shall not contain any chlorides, nitrates, sulphides or sulphites. Where more than one admixture is included in the shotcrete mixture, they shall be chemically compatible. Approval of the shotcrete admixture shall be subject to satisfactory demonstration of suitability of the proposed shotcrete mixture through the construction of

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trial panels and acceptable quality assessments conducted on a minimum of three test panels representing three independently batched shotcrete mixes.

3.5 MESH REINFORCEMENT

All mesh reinforcement shall comply with SANS 1024. Mesh reinforcement shall be welded steel fabric mesh (SANS 1024) as specified in the drawings or Contract Documentation. Reinforcement cover will be indicated on the construction drawings.

3.6 FIBRE REINFORCEMENT

Fibre reinforcement shall comprise steel or polymer fibres as specified in the drawings or Contract Documentation.

All steel fibres for concrete shall comply with EN 14889-1 or ASTM A820 and all polymer fibres shall comply with EN 14889-2 or ASTM D7508. All fibres shall be submitted to the Engineer for approval prior to the commencement of work.

It is common practice to utilise fibre lengths up to 30mm for the dry process and up to 40mm for the wet process and the length of fibres shall not exceed 70 per cent of the minimum internal diameter of the pipes and hoses used, unless it has been proven that longer fibres can be used without blockages.

3.7 COMPRESSED AIR FOR SPRAYED CONCRETE

Compressed air used in the process shall be clean, dry and free of oil.

For lengths of hose up to 30m, the air pressure at the nozzle shall be 300kPa or more. Where the length exceeds 30m, the pressure shall be increased by 35kPa for each additional 15m of hose required. Constant pressure shall be maintained. The nozzles used shall have a maximum diameter of 40 mm.

3.8 COMPRESSIVE STRENGTH, ULTIMATE FLEXURAL STRENGTH AND ENERGY ABSORPTION CAPACITY

The Contractor shall be responsible for design of the shotcrete mix in order to produce shotcrete that complies with the requirements for each class of shotcrete. Class of shotcrete is indicated by the designated code SP, the characteristic cylinder compressive strength in MPa at 28 days. For example, SP25 means shotcrete with a characteristic cylinder strength of 25MPa after 28 days.

Minimum ultimate flexural strength requirements shall be as shown in drawings or as specified in the Contract Documentation. In special applications, reinforcement in the form of flexible high tensile wire mesh, double twist mesh and chain link-type systems shall be specified in the Contract Documentation or shown on drawings as encapsulated in shotcrete. Details of the earth spikes, soil nails, rockbolts and other reinforcement fastening system shall be shown on the drawings or specified in the Contract Documentation.

Where required, the minimum energy absorption capacity of fibre reinforced shotcrete shall be specified in the Contract Documentation or indicated on the drawings. Energy absorption capacity shall be determined from a slab specimen, tested at 28 days in accordance with EN 14488-5.

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3.9 DRAINAGE SYSTEMS, GEOPIPE COLLECTORS AND WEEPHOLES

Weephole material shall be U-PVC pipes and shall comply with SANS 966-1.

Water collection geopipes shall be perforated or slotted U-PVC pipes that comply with SANS 791. The size of perforations in perforated pipes shall in all cases be 8mm in diameter plus or minus 1,5mm, and the number of perforations per metre shall not be fewer than twenty-six for 100mm pipes and fifty-two for 150mm pipes. Perforations shall be spaced in two rows for 100mm pipes and in four rows for 150mm pipes. Slotted pipes shall have a slot width of 8mm with a tolerance of 1,5mm. Arrangement of slots shall be subject to approval by the Engineer, but the total slot area shall not be less than that specified for perforations. Installed pipes shall protrude 50mm beyond the surface of final shotcrete layer and have their inner slotted section end wrapped with a single layer of approved geosynthetic. Pipes without slots or perforations required for transporting water from the drainage system to point of discharge shall be U-PVC.

Geocomposite/geosynthetic drains shall be of type specified in the Contract Documentation and shown on the drawings. Strip or band drains generally 150mm wide geosynthetic which discharge into weepholes installed through shotcrete lining are commonly specified. Such shall be detailed on the drawings where these drain types are specified. These materials shall be protected against sunlight and mechanical damage during storage and installation. Geosynthetics shall be non-woven, spun or thermic-bonded filament consisting of more than 85% by mass of polypropylene, polyester or other approved material and manufactured for civil-Engineering applications by a recognised manufacturer.

3.10 QUALITY

Where there is a standardisation mark programme for any material, all such material supplied shall bear the official standardisation mark.

Alternative materials or equipment proposed by the Contractor shall be tested. The test, as well as the materials or equipment, shall be approved by the Engineer prior to any such materials or equipment being built into the works and all costs involved in testing shall be deemed to be included in the rates tendered.

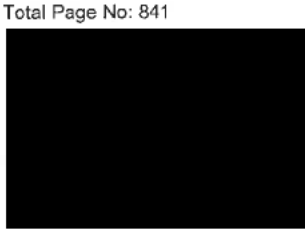
4. CONSTRUCTION EQUIPMENT

Plant used for shotcreting shall be based on proven technology within the industry and shall be in good working order. Plant shall be inspected, serviced and calibrated at regular intervals and tested to ensure system functionality, efficiency and accuracy; all to Engineer-satisfaction.

Type and capacity of delivery hoses and nozzles shall be such as to ensure a uniform mix and supply of mix ingredients to mixing nozzle, thereby obtaining correct consistency and a uniform discharge rate from nozzle. The Contractor shall provide on-site a standby hose of capacity similar to the one in use to maintain continuity of work in case of a hose blockage. Hoses shall be blown clean before any work is stopped.

a) Dry-mix process

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Air operating pressure supply at the gun outlet shall be greater than 300kPa, and shall, as a minimum, be capable at all times of maintaining a discharge nozzle velocity of 90 to 120m/sec. Water added at nozzle shall be supplied at a uniform pressure of 100kPa greater than air pressure at nozzle. Supply of water to mixing nozzle shall be such that a pressure of greater than 400kPa or as dictated in the approved method statement can be maintained.

b) Wet-mix process

Air compressors and delivery hose lines shall be of adequate capacity and size to provide a pressure of greater than 300kPa at nozzle for 25mm nozzles and proportionally greater for larger nozzles or as dictated in the approved method statement.

5. EXECUTION OF THE WORKS

5.1 MIX DESIGN

The Contractor shall submit details of the proposed shotcrete mix proportions prior to commencement of shotcrete activities for approval as per table below.

Table SC1: Approvals required.

Requirement	Lead time
Shotcrete mix design	6 weeks before construction
Details of admixtures	1 week prior to use
Test panels	6 weeks before construction
Construction method statements	6 weeks before construction

Shotcrete operations shall only commence after approval of the mix design. The Contractor shall allow adequate programme-time for design and approval of the shotcrete mix design. Mix ingredients and material source shall not be altered during construction without the prior approval of the Engineer. Shotcrete shall be designed to yield a 28-day characteristic compressive strength as shown on the drawings for different application areas or as specified in the Contract Documentation.

5.2 CERTIFICATION OF SKILLED OPERATORS

Only experienced foremen, gunmen, nozzlemen and rodmen shall be employed, and satisfactory evidence of such experience shall be furnished with the Engineer. Nozzlemen shall be highly skilled craftsman with demonstrable personal project history exceeding 4000 hours of spraying concrete as the responsible nozzleman, or minimum 5 years' referenced experience as responsible nozzleman. A nozzleman without demonstrable practical experience as specified above shall be trained and certified as a nozzleman for the proposed shotcrete process and proposed spraying orientation in accordance with the standards of, for example, the Shotcrete/ Sprayed Concrete Association (UK), American

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Shotcrete Association, American Concrete Institute or other relevant certification authority approved by the Engineer.

Preconstruction trial panels

The Contractor shall provide trial panel formers made of nominal 20mm thick shutter ply, size 600mm by 900mm skirted with reinforcement as detailed in drawings, or where no reinforcement is required a light expanded metal mesh, standing at least 200mm high around panel-edges.

Where ultimate flexural strength requirements are specified, additional trial panels will be required.

Where energy absorption capacity is specified, specimen slabs constructed in accordance with EN14488 shall be required.

5.3 SURFACE AND SLOPE PREPARATION

All soil and rock to be covered with shotcrete shall be neatly trimmed manually where required and thoroughly cleaned with compressed air to remove all loose fragments of rock and soil as required, the Contractor must make allowance for the Engineer to approach within 2,0m of any portion of area to be covered with shotcrete. Where soft material is to be covered with shotcrete, only obviously loose material shall be removed and boulders shall be thoroughly cleaned with compressed air. The area of soft material shall be accurately graded to plan dimensions and shall be thoroughly compacted, with sufficient moisture to provide a firm foundation to prevent absorption of water from the shotcrete, without free surface-water. An initial layer of shotcrete with specified nominal thickness shall be applied to approved, clean areas of soft material with minimum time delay. Irregular and rough rock contours, particularly rock surfaces resulting from drill and blast excavation techniques, may require the application of an initial smoothening layer of shotcrete to a specified nominal thickness.

When shown on the drawings, joints, side formwork, headers, and shooting strips shall be provided for backing or panelling, stainless steel gauging wires, spacers, inserts and profile boards shall be used where necessary to establish and control thicknesses, surface planes, and finish lines during application of the shotcrete.

Geocomposite band drains shall be installed at the required locations as specified in the Contract Documentation and drawings prior to initial shotcrete application. Groundwater seepage shall be collected in hoses, pipes or other drainage systems to prevent damage, and reduced shotcrete quality.

5.4 FORMWORK

Formwork and shooting strips for shotcrete shall be employed to ensure square corners, straight lines and a plane surface of shotcrete, except as otherwise permitted by the drawings or the Engineer's approval. Formwork and shooting strips shall be designed and placed to avoid pockets of rebound.

5.5 FIXING OF REINFORCEMENT

Reinforcement shall be securely fixed over initial shotcrete layer/s by fastening to dowels and, where necessary, ties embedded in shotcrete via gun nails, "n" bolts or other

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approved fixing systems. Reinforcement shall be fixed so that it lies snugly against the initial shotcrete layer ensuring it will not vibrate during application of successive shotcrete layers thereby ensuring voids are not formed between the shotcrete layers. Where sudden concave or convex surfaces preclude this, the reinforcement may be cut so that smaller pieces can be formed into the curved surfaces. The minimum overlap of mesh reinforcement shall be 150mm, unless otherwise mandated by specific requirements of flexural or energy absorption reinforcement systems. Spacers shall be used behind mesh where required and where no flashcoat has been placed.

The Contractor shall provide details of the fixing system he proposes to use to the Engineer one week prior to use. Improvements/ changes shall be carried out during shotcreting as directed by the Engineer.

5.6 WEATHER LIMITATIONS

Shotcrete shall not be placed on a frozen surface or when ambient temperature is less than 5°C; nor shall it be placed when it is anticipated that temperature during the following 24 hours will drop below 1°C. Application of shotcrete shall be suspended if high winds prevent proper application, or if rain occurs since this would wash out shotcrete mortar.

5.7 MIXING AND BATCHING

Cement, aggregates, fibres, admixtures and approved additives shall be batched by mass to an accuracy of approximately 5%. For wet- and dry-mix spraying methods, the mixer shall be capable of achieving a uniform distribution of constituent materials. Mixing shall continue until the mix exhibits a homogenous appearance, ensuring complete coating of fine aggregate particles with cementitious material and for a period of more than 90 seconds thereafter. Special care shall be taken when adding fibres to ensure uniform dispersion.

Any mix spilled during handling or ejected from shotcreting equipment shall not be re-used. The mix shall be screened prior to gun-loading to prevent inclusion of stones, cement bag scraps or other foreign materials. Prepared batches shall be discharged through the nozzle within 60 minutes of mixing.

5.8 DELIVERY

a) Dry-mix process

Shotcrete shall be applied as dry as practicable to prevent shrinkage cracking, while ensuring a compacted dense homogeneous mass. Appropriate measures shall be taken to ensure that fresh concrete remains sufficiently workable until end of spraying. Dry mix compositions with moist aggregate shall normally be applied within 60 minutes after mixing and shall be discarded after such elapsed period. If more than 60 minutes is required until the end of spraying of a batch, open time provided by the chosen measures shall be demonstrated and verified in advance to the Engineer's satisfaction.

Dry mix composition with oven or kiln dried aggregate may be stored for a limited time but shall be applied immediately after mixing with water. Oven or kiln dried material should be pre-dampened before the nozzle or before it is loaded in the spraying machine. When adverse weather conditions require use of quickset cement, procedures shall be adjusted to allow for limited open time of the mix.

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Detrimental changes in the dry mix, such as segregation, or other changes shall be minimized during loading, transporting and unloading as well as during conveying on site. Plant shall be chosen, screened off and suitably controlled in a manner that prevents excessive cement dust generation and aggregate separation.

b) Wet-mix process

Measures shall be taken to ensure that mixed constituents remain sufficiently workable until end of spraying. Normal workability time shall be determined by pre-construction tests on test panels. If work requires longer workability times it shall be verified by additional tests. Wet mix compositions shall be applied within 60 minutes after mixing and shall be discarded after such elapsed period. Detrimental changes to the base mix, such as segregation, bleeding, paste loss, or other changes shall be minimized during loading, transporting and unloading as well as when being conveyed on site.

5.9 APPLICATION OF SHOTCRETE

Mix temperature and consistency of shotcrete on site shall be monitored and controlled to ensure conformity before shotcreting. All adjustments of the shotcrete stream through nozzle, whether air pressure, accelerator or shotcrete stream, shall only be performed when the nozzle is turned away from the substrate. Shotcrete shall be composed and sprayed in a manner to limit rebound. Important factors influencing rebound, such as concrete composition, nozzle angle and the distance to substrate, accelerator dosage, particular area of application, etc. shall be carefully controlled and monitored on a continuous basis during application by competent Contractor supervisory staff.

The nozzle shall be directed, wherever possible, normal to the application surface, to produce a layer of optimum density and thickness, with full encasement of reinforcement and minimum rebound. The distance between the nozzle and shotcrete surface is determined according to site conditions and the possibility of obtaining good compaction, full encasement of reinforcement, and minimum rebound. For rock support normally a distance of 1,0m to 2,0m is recommended, although site conditions may dictate an application distance outside this suggested range.

Thickness of each shotcrete layer depends on several parameters and shall be based on site conditions and composition of the mix. Specified nominal shotcrete thickness may necessitate the application of two or more layers to avoid sagging and sloughing, particularly with overhead work. Thickness of layers may be increased via use of admixtures such as accelerators; extenders such as silica fume, or the use rapid-hardening cements.

A subsequent layer shall not be applied before the preceding layer is able to support it. Earlier applied shotcrete, should considerable time elapse between placement of different layers to obtain specified nominal thickness, shall be cleaned either by blowing with compressed air, high pressure washing, brushing or sand blasting and rewetted until suction of substrate, and consequent risk of an adverse influence on the subsequent shotcrete layer, is mitigated, as approved by the Engineer.

All shotcrete shall be of a homogenous composition without any inclusion of rebound. Overspray and loose rebound material shall be removed from surrounding areas and from substrate before shotcrete is applied to new or subsequent sections. Pre-wetted substrates shall be free from running water.

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When spraying on or through reinforcement, consequence of rebound and shadow effects shall be carefully taken into account and particular attention given to minimize all possible negative effects. Mitigation measures may include ensuring that the air stream velocity around reinforcement is sufficient and ensuring encapsulation of reinforcement is completed as soon as practical with adequate cover over reinforcement and preventing poor compaction, if spraying with fibres onto other types of reinforcement.

5.10 FINISHING

The finished surface shall generally follow the contours of the roughly trimmed face such that it mimics the natural rock faces. It shall, however, be free from rebound pockets or other defects. The inclusion of fibres may affect the finish obtained. The types of finish shall be designated on the drawings by the following:

- SU: Undisturbed nozzle finish
- ST: Trowelled finish
- STB: Trowelled and brushed
- STF: Trowelled and flash-coated
- STW: Trowelled and wood floated.

The general procedure for achieving required finishes shall be:

Undisturbed nozzle finish (SU)

- The sprayed surface shall be brushed with a soft plasterer's brush approximately one hour after placement to remove adhering rebound dust and to prevent surface crazing.

Trowelled finish (ST)

- The surface shall be trowelled when the shotcrete exhibits initial set to obtain a uniform curved or plain surface true to line and shall then be finished with one of the following treatments if so specified:

Brush-coated (STB)

- Coating of the trowelled surface with a cement mortar slurry using a soft broom or brush to give a soft "brushed effect"

Flash-coated (STF)

- Coating the trowelled surface with a thin uniform layer approximately 3,0mm thick of shotcrete at least four hours after trowelling but not later than eight hours.

Wood-floated (STW)

- Floating the trowelled surface with a wood float to produce a smooth even surface free from trowel marks

5.11 REBOUND MATERIAL

Rebound material shall not be re-used. Rebound material shall be removed from all future working areas and may not be covered up by subsequent applications of shotcrete. It shall also be cleaned from the surface of any finished work. Where coarse aggregate >10mm is used, higher rebound volumes are anticipated. There may be an increased proportion

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of fibres in rebound when fibres are used. Appropriate correction to mix design will be required.

5.12 PROPERTIES OF HARDENED SHOTCRETE

a) Compressive strength

To determine compressive strength, characteristic cylinder strength, determined from cores extracted from test panels, using 75mm diameter, 150mm high cylinders prepared strictly in accordance with SANS 3001-CO2-2 and tested in accordance with SANS 3001-CO2-3 at a sample age of 28 days.

For specific uses, it may be necessary to specify compressive strength at ages earlier or later than 28 days, or after storage under special conditions. In assessing strength, other sizes of specimens and other curing regimes may be used in relationship to those standardised is established and documented.

b) Flexural strength

Ultimate flexural strength shall be determined from beam specimens cut from test panels, tested at 28 days in accordance with SANS 5864.

c) Energy absorption capacity

Energy absorption capacity shall be determined from a test panel slab specimen, tested at 28 days, in accordance with EN 14488-5, and shall conform to specified energy absorption class defined in Table SC2.

Table SC2: Energy absorption classes and values.

Energy absorption class	**Energy absorption for deflection up to 25 mm (J)**
E500	500 to 690
E700	700 to 990
E1000	1000 and greater

5.13 CONSTRUCTION JOINTS

Once a section of work has commenced, the application of shotcrete shall be continuous up to the construction joints shown on the drawings or up to approved locations. All construction joints shall be standard feathered type joints, for last mix of the day the shotcrete layer shall be tapered to a fine edge which shall be wet and cleaned with an air or water blast before joining the following day's work. Irregular edges shall be cut back to straight lines before commencing with further work.

5.14 WEEPHOLES

Weepholes comprising nominal 50mm diameter U-PVC piping shall be installed at those positions indicated on the drawings or as otherwise Engineer-instructed. Pipes shall

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protrude 20mm beyond the surface of final shotcrete layer and have their inner end wrapped with a single layer of geosynthetic. Weepholes shall be positioned to intersect seepage anticipated from soft zones or fixed in position to butt against angled or vertical geosynthetic band drains. Weepholes shall be positioned prior to application of initial shotcrete layer with the geosynthetic end hard against substrate face.

Outer ends of the pipes shall be adequately protected during application of shotcrete. Protective plugs shall be removed after spraying and pipe checked to ensure no shotcrete material entered any of the weepholes.

5.15 CONTROL TEST PANELS

The Contractor shall produce control test panels, fully complying with requirements of the preconstruction trial panels, alongside every new stage of the work. A minimum of one control test panel required per lot of shotcrete, and at least one per day. At the start of or during work, nozzle operator shall produce test panels alongside and in similar orientation to the work. These test panels shall be protected and cured in the same manner as the work.

5.16 EDGE DETAIL OF SHOTCRETE

Details of finishing off shotcrete at the brow and edges shall be indicated on drawings. Methods to terminate shotcrete at the perimeter shall prevent surface water from undermining the shotcrete. For tender purposes, allowance shall be made for trench excavation along the perimeter with nominal dimensions of 0,5m wide and 0,5m deep or as indicated on the drawings, to allow for the finishing off of shotcrete at the edges

Where boulders or suitable quality rock outcrop occur at a cut-brow, no cut off may be required, if Engineer-instructed, and shotcrete shall be neatly stopped at rock surface -top. Where specified on drawings, shotcrete shall be terminated to facilitate incorporation of precast coping units.

5.17 AESTHETIC APPEARANCE

The Contractor shall take due care in assessing variation in texture and colouring of natural adjacent rock and soil slopes. Finish of all permanently visible shotcrete surfaces shall be in harmony with surrounding environment. The Contractor shall pay particular attention during application of shotcrete to carefully control desired variations in colouring and texture of shotcrete to suit the natural local environment. Colour pigmentation shall be agreed in collaboration with, and approval of the Engineer via trial colour panels. In some locations, the Engineer may instruct the formation of planting boxes in which vegetation may be planted. Where so required details shall be given in the Contract Documentation.

5.18 PROTECTION OF ADJACENT WORK

During the shotcreting progress, where appearance is important, adjacent facilities or structures which may be permanently discoloured, stained, or otherwise damaged by overspray, dust or rebound, shall be adequately protected and, if contacted, shall be cleaned at the Contractor's cost by early scraping, brushing, or washing, as surroundings permit.

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5.19 BLASTING RESTRICTION

To prevent damage to shotcrete, no blasting shall be carried out within 50m of a shotcrete section within 72 hours of shotcrete-application. The total explosive charge detonated instantaneously shall be such that Peak Particle Velocity (PPV) less than 50mm/s. All completed works shall be inspected after any blasting within 100m of the shotcreted area.

5.20 PROTECTION AND CURING

a) Protection from adverse environmental conditions

The finished sprayed concrete surface, including all intermediate layers, shall be protected from drying out and direct sunlight by all suitable means subject to the approval of the Engineer. The ambient temperature, the relative humidity, sprayed concrete temperature and wind speed shall be actively monitored to ensure that the rate of evaporation is minimised and at all times limited to maximum 1,0kg per square metre per hour in accordance with ACI 305R or the Concrete Society of Southern Africa technical report on Concrete Curing (November 1991, ISBN 0-620-16248-1).

Where the ambient temperature exceeds 30°C, the formwork, reinforcement, and all surfaces that will come into contact with the sprayed concrete shall be shaded and cooled to below 30°C to the satisfaction of the Engineer. Measures shall be taken to protect against frost when spraying in cold weather, or when spraying against frozen concrete, rock and soil surfaces. Such protection shall be in place until the sprayed concrete has developed a compressive strength of at least 5MPa.

b) Curing

The use of a sprayed surface curing compound will not be permitted. Damp curing shall continue for at least seven days. The sprayed concrete shall be kept moist a fine mist of water at intervals not exceeding 4 hours.

5.21 METHOD STATEMENT

The Contractor must submit a method statement for approval for the manufacture and application of sprayed concrete, inclusive of the following:

a) details of equipment and materials to be used for the manufacture and application of sprayed concrete
b) application of sprayed concrete
c) curing and protection of sprayed concrete surfaces
d) method of making good any damaged surfaces
e) measures up to establish finished surfaces and to guarantee minimum concrete thicknesses.
f) testing procedures

5.22 RECORDS

Records of the manufacture, application and testing of sprayed concrete must be kept and submitted to the Engineer for approval.

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6. WORKMANSHIP

6.1 TOLERANCES

The tolerances provided below shall be maximum permissible deviations from specified dimensions, levels, alignment, positions, etc., as shown on drawings.

- Position: the lesser of 100mm or the specified position of the total shotcrete member.
- Thickness - Arithmetic mean value per lot: minimum 100% of specified layer thickness, maximum thickness not specified.
- Individual depth at any measurement point: minimum 80% of specified layer thickness, maximum thickness not specified.
- Surface regularity (where applicable): maximum value of any individual irregularity, measured with a custom template that ensures specified layer thickness is achieved and is less than 25mm.

6.2 ACCEPTANCE CRITERIA

The onus rests with the Contractor to produce work and products which comply with the characteristics and requirements of the specifications and drawings in all respects. The Contractor shall institute a quality management system and provide experienced engineers, technicians, foremen, inspectors and other technical staff, under the control of a designated quality manager, to give effect to and manage the quality management system.

Where any performance-based specifications apply, the Contractor shall institute a quality management system that will ensure and demonstrate that the required performance standards have been met and, where applicable, will continue to be met for any period which has been specified in the Contract Documentation.

The quality management system shall outline the minimum requirements and actions to be taken during the construction of all elements of the Works and shall include monitoring of the various properties of the elements of the Works using either a fully ISO certified quality assurance system or an appropriate quality management system based on recognised sampling and testing principles.

The Contractor shall carry out testing and measurement in accordance with the requirements specified in the Contractor's quality management system to confirm the conformance of the Works with all the relevant requirements and specifications. Although it is not a requirement for the Contractor to conduct regular tests and measurements on commercially produced products bearing the SANS, or any other internationally recognised, specification for products such as cement, road-lime, paint, bitumen, steel pipes, sealants and bridge bearings etc., the quality of such materials and products shall nevertheless be checked on a regular basis in liaison with the Engineer. The costs for any such sampling, tests and measurements shall be borne by the Employer in the event of compliance with the requirements and specifications. In the event of non-compliance with the requirements and specifications the costs for any such sampling, tests and measurements and subsequent corrective or remedial actions shall be borne by the Contractor.

All measurements and test results shall be submitted, without delay, to the Engineer on the completion of each element of the Works. Should the sampling, testing and

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measurements for any end product be carried out by the accredited combined laboratory, or any other accredited laboratory or institution, and prove compliance with the specifications, the Engineer may accept these results for acceptance control purposes at the cost of the Employer. In the event of method specifications being applicable for the construction of certain layers, products or elements, the Contractor shall follow the proposed methodology given in a method statement that has been commented on and/or accepted by the Engineer. Where applicable the methodology to be used and the acceptability of the work / product shall be demonstrated by means of an appropriate trial section carried out by the Contractor. Any subsequent deviation from the proposed methodology shall be submitted to the Engineer for comment prior to implementation.

All completed elements of the Works shall be submitted to the Engineer for written acceptance and the Contractor shall not cover up any completed work prior to such acceptance being issued. The Contractor shall plan, and make arrangements for, the submission of work for acceptance control in a manner which will afford the Engineer a reasonable and timeous opportunity for inspection, testing and measurement of the Works.

The Contactor shall agree all the process control sampling, testing, measurement and approval processes with the Engineer for each element of the Works before commencing work. Regardless of the acceptance of any materials or products based on the Contractor's process control, the Contractor shall remain fully responsible for any defective material, product or plant/equipment used in the temporary and permanent Works.

Acceptance quality control shall be conducted by the Employer and/or the Engineer and it shall consist of visual inspections, sampling, testing and measurements in terms of the methods and procedures specified in the Specifications and/or in the Contract Documentation in order to ensure that the Contractor complies with all his obligations prior to the acceptance of and payment for the Works.

In the event of elements constructed using method specifications, the Engineer shall regularly monitor and inspect the process visually and ensure that the work is constructed in accordance with the approved method statement as well as with any applicable industry norms, standards and best practices. The Engineer may, however, request any sampling, tests and measurements of the final product to ensure conformance to the design requirements. The costs for any such sampling, tests and measurements shall be borne by the Employer in the event of compliance with the requirements and specifications. In the event of non-compliance with the requirements and specifications the costs for any such tests shall be borne by the Contractor.

Regardless of the Employer's quality control acceptance of any materials or products the Contractor shall remain fully responsible for any defective material, product or plant/equipment used in the temporary and permanent Works.

Compressive strength shall be determined using cored cylinder specimens prepared in accordance with SANS 3001-CO2-2 and tested in accordance with SANS 3001-CO2-3 at the age of 28 days.

7. MEASUREMENT AND PAYMENT

a) Preamble

The tendered rate for each pay item shall include full compensation for providing, operating, maintaining, and decommissioning upon completion, of all the construction

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equipment, labour, tools, incidentals and supervision to carry out the activity or construct the works in the pay item as specified, unless otherwise stated.

Any prime cost or provisional sums shall be paid in accordance with the provisions of the conditions of contract. The charge or mark-up tendered or allowed for is a percentage of the amount actually paid under the prime cost or provisional sum. This percentage shall cover all the Contractor's handling, supervision, profit and liability costs to provide the services in the prime cost or provisional sum item.

Where pay item descriptions include any wording in brackets it is an indication that contract specific information is to be inserted in the Pricing Schedule included in the Contract Documentation.

b) Items that will not be measured separately

The following activities, whether required to complete the specified work or not, will not be measured and paid for separately and the Contractor shall include the cost thereof in other pay items as the Contractor deems appropriate:

1. No separate payment will be made for backfilling excess excavations, disposing of surplus material etc. or any other contingent work, unless the work is specifically specified or ordered.
2. No separate payment will be made for setting out the works.
3. No separate payment will be made for the protection or repair as required of any existing or new road furniture, structures, buildings, infrastructure or services damaged by the Contractor's activities.
4. No additional payment shall be made, nor shall any claim for additional payment be considered, for any specified work in confined or restricted areas. Any additional costs associated with working in confined or restricted areas shall be deemed to be included in the standard applicable pay items.
5. No separate payment will be made for the loading of any materials.
6. No separate payment will be made for the hauling of any materials where the material is moved over a distance of less than, and up to, 1,0 km.
7. No separate payment will be made for transporting materials from commercial sources irrespective of the haul distance.
8. No separate payment will be made for the removal of any surplus material imported to complete the works.

c) Items specifically for this Section of the specification

Item	Description	Unit
SC1	Establishment on site	lump sum

The tendered lump sum shall include full compensation for establishing on site all plant and equipment, scaffolding, platforms, materials and personnel necessary to carry out the specified work and for the removal from site of all such plant and equipment including all temporary works such as access roads, staging, platforms and such like on completion of the works.

Work shall be paid as Lump Sum, 50% of which will be due when all equipment is on site, trials (if any) are completed, and the first production shotcrete has been applied to full thickness as specified. A second instalment of 25% shall be payable after half the shotcreting has been completed and final 25% after all the shotcrete has been applied - and accepted - and all equipment and plant removed from site.

Item	Description	Unit
SC2	Surface preparation for shotcreting	square metre (m^2)

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The unit of measurement shall be the square metre of face/slope cleared of all loose or unwanted material, including indicated vegetation, and manually trimmed to designed lines and levels as specified. The tendered rate shall include full compensation for trimming all material, and for all equipment, labour and other incidentals necessary to complete the specified work.

Item	Description	Unit
SC3	Supply and installation of reinforcement:	
SC3.1	Welded steel mesh fabric (Ref. 395)	square metre (m^2)
SC3.2	Fibre (type indicated)	kilogram (kg)
SC3.3	Other special reinforcement systems as specified	square metre (m^2)

The unit of measurement for steel mesh shall be the net square metre of reinforcement incorporated into shotcrete. Measurement shall be based on square metre of soil and or rock slope covered with mesh and measured on the plane of the slope. No overlaps of mesh and or reinforcement system shall be measured.

The unit of measure for fibre shall be the mass in kilograms of fibre used, as determined by the kilogram of fibre per cubic metre of shotcrete specified. The tendered rate shall include full compensation for supply and installation, including all equipment, plant, materials, labour and incidentals necessary to carry out the specified work and including specifically supply and installation of pins, earth spikes, soil nails/ rockbolts, wire ties, gun nails and any other approved fastenings for the completion of the work as specified.

Item	Description	Unit
SC4	Shotcrete (of specified thickness or volume):	
SC4.1	Flash/base coat (unreinforced) (specify thickness)	square metre (m^2)
SC4.2	Intermediate coat/s (specify thickness and number of layers)	square metre (m^2)
SC4.3	Final coat (specify thickness, pigmentation and finish	square metre (m^2)
SC4.4	Dental shotcrete	cubic metre (m^3)

The unit of measurement shall be the net square metre of face measured in the plane of the cutting face, which is protected by shotcrete of specified nominal thickness, installed as specified. No separate allowance shall be made for an uneven surface when measuring the area over which shotcrete is applied.

The unit of measurement for dental shotcrete shall be the cubic metre of shotcrete of measured batch volume, agreed with the Engineer and installed in accordance with the specifications. The tendered rate shall include for everything necessary to carry out specified work as specified and shall include safe access for the Engineer to any portion of the cut face or slope. Payment shall only be made for dental shotcrete where it is required for reasons out of the Contractor's control, as determined by the Engineer. No payment will be made for dental shotcrete where it is required as a result of the Contractor's negligence or poor working practices.

Item	Description	Unit
SC5	Removal to spoil of material trimmed from slope	cubic metre - km (m^3.km)

The unit of measurement shall be the cubic metre - kilometre which is calculated as the product of the quantity of material cleared, temporarily stockpiled, loaded, transported in excess of 1.0 kilometre and disposed at approved spoil site, in accordance with the requirements multiplied by the applicable haul distance which shall be calculated as defined in the construction documentation.

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The tendered rate shall include full compensation for trimming all material, and for all equipment, labour and other incidentals necessary to complete specified work. Haul distance shall be measured from mass-centre to mass-centre. The volume of such material shall be taken to be equal to 70% of the loose struck volume measured in the truck.

Item	Description	Unit
SC6	Edge finishing of shotcrete	metre (m)

The unit of measurement shall be the linear metre of perimeter where shotcrete is required to be finished off as detailed in the drawings, all as specified. The tendered rate shall include full compensation for excavation and spoiling of material from trenches, bending of mesh or reinforcement, application of shotcrete irrespective of volume involved as well as all equipment, labour, transport and other incidentals necessary to complete the specified work.

Item	Description	Unit
SC7	Geopipe collectors and weepholes:	
SC7.1	50 mm diameter U-PVC weephole piping (specify length and class)	number (No)
SC7.2	Geopipe collectors (specify type, diameter and class)	metre (m)
SC7.3	Other piping (specify type, diameter and class	metre (m)

The unit of measurement for the U-PVC weephole piping shall be the number of weepholes installed. Unit of measurement of the geopipe collectors and other pipes shall be the metre length installed. The tendered rate shall include full compensation for supply, installation, protection during shotcreting, geosynthetic wrapping, plant, equipment, labour and all other incidentals necessary to complete the specified work.

Item	Description	Unit
SC8	Geocomposite/geosynthetic drain as specified	metre (m)

The unit of measurement shall be the linear metre of geocomposite drain installed as specified at spacings or positions specified or as indicated on the drawings. The tendered rate shall include full compensation for supply, installation, protection during spraying, plant, equipment, labour and all other incidentals necessary to complete the specified work.

Item	Description	Unit
SC9	Sub-horizontal drains	metre (m)
SC9.1	Moving to, and setting up the equipment for drilling the holes at each position (specify type, diameter)	No.
SC9.2	Drill holes for horizontal drains (specify diameter, length)	metre (m)
SC9.3	Installation of slotted drainage pipes for horizontal drains (specify type, diameter and length)	metre (m)

The unit of measurement shall be the linear metre of geocomposite drain installed as specified at spacings or positions specified or as indicated on the drawings. The tendered rate shall include full compensation for supply, installation, protection during spraying, plant, equipment, labour and all other incidentals necessary to complete the specified work.

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MONITORING

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1 SCOPE

This section deals with the supply and installation of instruments to monitor the behaviour of the dam and concrete structures during construction and operation and the taking of measurements during the construction period. Not all monitoring equipment, although mentioned or discussed, are specified herein, and may be specified elsewhere, particularly the electronic equipment.

2 REFERENCES

Piezometers in Fully Grouted Boreholes by P.E. Mikkelsen and G.E. Green, Symposium on Field Measurements in Geomechanics, Oslo, Norway, September 2003.

3 GENERAL

3.1 GENERAL REQUIREMENTS

The Contractor shall, in accordance with the Specifications, the Drawings or as directed by the Employer's Agent:

- Supply and install mechanical instruments such as settlement gauges, piezometers, reservoir level indicator gauges, water level standpipes and water flow measuring weirs;
- Drill boreholes and excavate pits and trenches for the installation of the instruments in the dam fill, its foundation as well as the abutments and for the placing of cables;
- Connect the electrical instruments to a receiver box installed at the toe of the dam by means of single and multiple cables including junction boxes;
- Provide or construct protective surrounds and protective pipes for instruments and cables, and then protect the installed instruments and cables or tubes against damage;
- Supply portable recording equipment for instrument monitoring including all ancillaries.

Installation of instruments shall be performed simultaneously with the construction of the embankment dam. The Contractor shall prepare the layout and plan the instrumentation installation methods in such a way that construction delays are minimised and the instruments and cables are not damaged by the construction work. The Contractor shall install and protect all instruments and cables in such a manner that damage to the instruments or cables is prevented and long term operation is guaranteed.

The Contractor shall supply the instruments, including measurement devices, calibration certificates, calibration frames, auxiliary equipment etc., and supervise the installation and initial reading of the instruments. He shall arrange for the work to be carried out at the locations shown on the Drawings or where directed by the Employer's Agent.

The Contractor shall monitor and record the instrumentation readings until the issue of the Taking-Over Certificate. After taking measurements he shall submit the records to the Employer's Agent for evaluation.

The Contractor shall give sufficient notice to the Employer's Agent of his intention to read instruments to allow the Employer's Agent to witness or participate in taking the readings. The method statement for installation and reading of instruments and presentation of results shall be agreed with the Employer's Agent prior to any work being undertaken. The results of all readings, plotted on graphs as agreed, shall be handed to the Employer's Agent within 24 hours after readings have been taken. He shall also provide the Employer's Agent with the data in electronic format.

3.2 INFORMATION TO BE SUPPLIED

The Contractor shall, with due cognisance of the time required to order and supply the instruments, but not

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later than 90 days prior to the installation of the first instrument, submit to the Employer's Agent for his approval the following information and any other information required by the Employer's Agent:

- a detailed layout of the instruments and cabling system and routing, based on the relevant drawings;
- a detailed description of instruments finally selected and the ancillary measuring equipment;
- the Contractor's method statement for the installation, testing and operation of the mechanical and electrical instruments, based on procedures prepared by the manufacturer and/or suppliers;

During the execution of the Works, the Contractor shall submit to the Employer's Agent any further details regarding the instrumentation that require the Employer's Agent's approval.

Not less than 15 days before the anticipated date of installation of instrumentation in any particular location, the Contractor shall submit to the Employer's Agent for his approval details of his proposed installation procedure, details of the ongoing construction work in the vicinity of the instrument installation, the programmed sequence of events for the installation including details on the instrument(s) to be installed and their location(s), calibrating and zero measurements, personnel in charge, labourers, construction equipment and materials to be used. Within 5 days after the submission of the details, the Employer's Agent will give his approval with such modifications as may be deemed necessary.

4 PLANT

Plant and equipment used in handling, fabrication and erection shall comply with the applicable regulations of the Occupational Health and Safety Act, 1983 (Act 85 of 1993).

5 CONSTRUCTION

5.1 GENERAL

All instruments shall be tested and calibrated by the Manufacturer. The Contractor shall provide copies of such test and calibration certificates to the Employer's Agent. These instruments shall also be tested and, if required, recalibrated in the presence of the Employer's Agent before installation. The instruments shall be fitted with facilities for testing and recalibration.

All instruments shall be stored on site before installation in a secure, weatherproof and lockable building. The Contractor shall have all ancillary equipment, parts, fittings and materials as well as specifically required tools available for the installation of the instruments.

All instruments shall be installed complete with auxiliary equipment, devices, cables, tubes, protection measures and services to warrant proper function for the intended measuring purpose. Manufacturer's instructions are to be observed with respect to handling, testing, calibration, installation and functional testing.

The initial installation of each type of instrument, including calibration and functional tests, shall be performed under the direct supervision of the Manufacturer's expert who shall give on-the job training to the Contractor's supervisor and technicians who are responsible for the installation, testing and monitoring of instruments.

The Contractor shall also:

a) Excavate pits and trenches in dam fill or provide notches and openings in concrete for the installation of the instruments, cables and tubes;
b) Where required provide a sand bed and backfilling around instruments, cables and tubes;
c) Assemble the instruments and install them in the presence of the Employer's Agent at locations as indicated in the Drawings or as directed by the Employer's Agent. The installation shall preferably be performed during daylight hours. If the installation has to be performed during nighttime or in underground structures, the Contractor shall provide sufficient lighting to ensure proper execution of the installation work;

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d) Protect the installed instruments and cables or tubes against damage; the Contractors attention is brought to the potential damage caused by compaction equipment for overlying fill works. Where necessary he shall expose all temporarily buried instruments to continue their installation or connections;
e) Connect cables and tubes in the maximum practicable length to the instruments and install them in horizontal, vertical and inclined sections without joints, combine single cables with multiple cables as appropriate and, where permitted and approved by the Employer's Agent, splice and couple cables and tubes in accordance with the Manufacturer's recommendations;
f) Keep the open ends of all incomplete lines of tubing and casing plugged, sealed and protected;
g) Determine the exact location and elevation by topographic survey immediately after the installation of the instrument; and
h) Tag all cables and tubes with identification tags approved by the Employer's Agent at intervals of approximately 50 m or at such closer intervals as necessary to provide continuous identification.

If, as determined by the Employer's Agent or Contractor, there has been any damage to or displacement of the instruments and connections during the installation and progress of work, the Contractor shall immediately repair the damage or replace the instruments to the satisfaction of the Employer's Agent, all at the expenses of the Contractor.

All materials and works shall be in accordance with the relevant parts of this Specification.

5.2 SETTLEMENT BEACONS, PINS AND SURVEY REFERENCE BEACONS

5.2.1 General

The Contractor shall supply and install settlement beacons which will be located on the embankment crest, settlement pins which will be located on the reservoir roof topping, and survey reference beacons on the edges of the property boundary, to be used as references for the topographic survey of the dam. The settlement beacons and pins should be completed before the commencement of impoundment. The reference beacons should be installed shortly after the commencement of activity on the site such that they can be used as reference during all phases of construction.

5.2.2 Type of Instrument and Installation

The settlement beacons shall consist of a concrete block cast into the dam surface with a benchmark as shown on the Drawings. The benchmark shall be embedded in the concrete block cast in the surface of the dam embankment. The shaft is to be fully embedded in concrete and the head of the benchmark shall be provided with an engraved cone-shaped indentation serving as a centring mark. The identification number as indicated on the Drawings is to be clearly marked or imprinted on the concrete surface while still green. In addition on a non-corrosive metal tag with the identification number shall be affixed to the top surface of the beacon.

Settlement pins shall consist of stainless steel pins of 6 mm in diameter, or M6 bolts, and shall be drilled and chemically anchored in the roof topping slab to a depth of at least 30 mm. A stainless steel (or other approved noncorrosive durable metal) plate tag with the identification number of the settlement pin shall be firmly mechanically fastened to the concrete at each pin. The identification number shall be clearly and neatly imprinted/debossed into the metal tag.

Survey reference beacons shall consist of a concrete pillar and base as detailed in COLTO specifications and indicated on the Drawings.

Settlement beacons, settlement pins and survey reference beacons shall be installed at locations as indicated in the Drawings or as directed by the Employer's Agent. They shall be installed within 1 m of the indicated position and as directed by the Employer's Agent.

5.2.3 Testing, Surveying-In and Measurements

After the installation of each survey monument and displacement pin the accurate co-ordinates and the

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precise levelled elevation shall be determined by survey conducted by a registered land surveyor. This initial measurement shall be deemed to be the zero measurement. The zero measurement shall be checked and confirmed within one week of installation.

The exact location and elevation of the survey monuments and benchmarks shall be regularly surveyed monthly by triangulation from control beacons by the Contractor until the issue of the Taking-Over Certificate.

5.3 PIEZOMETERS FOR MEASURING PORE WATER PRESSURE

5.3.1 General

For the observation of pore water pressures within the dam foundation to a maximum depth of 17 m below NGL and within the dam embankment pore water pressure measurement devices (electronic piezometers) shall be installed as shown on the Drawings or directed by the Employer's Agent.

The requirements of this Specification include the supply of piezometers with cables and ancillaries, drilling of the boreholes into the foundation, the installation of the instruments and cables during construction of the dam, the connection of the cables to a monitoring terminal and monitoring and reporting of the porewater pressure during construction.

Note that the main purpose of the piezometers is to monitor the pore pressures in the foundation which will dictate the speed of embankment construction, i.e. the incremental lifts of earthfill placement that can be placed in a given time period. Their importance to the contractor's allowed rate of embankment construction is highlighted. They will continue to be monitored for a short period of post-completion.

5.3.2 Type of Instruments and Installation

All materials and works shall be in accordance with the relevant parts of this Specification.

The location of each piezometer and the cabling system shall be as shown on the Drawings or approved by the Employer's Agent. The equipment shall consist of an electronic piezometer with appropriate filter to suit the particle size distribution of the fill material at the location of installation, and an electrical measuring cable connection.

The Contractor shall supply and install piezometers which operate on a vibrating wire system. Each individual piezometer shall be connected to the monitoring terminal by means of a high pressure water proof cable, junction boxes and heavy duty multi-core collector cable.

The placing of the piezometer in the foundation shall be in boreholes drilled into the foundation. The method of forming boreholes and advancing casing shall be approved by the Employer's Agent before commencement of the works. Both rotary and percussion drilling methods may be used unless otherwise specified in project documents. Boreholes shall be cased full depth. Drilling aids, muds and additives may only be used if approved by the Employer's Agent. Where piezometers are to be installed, additives, muds or drilling aids shall be used. If drilling aids are used for drilling, they shall be biodegradable and shall be removed from the hole by flushing until the water return is clear. The utmost care shall be taken to minimize the disturbance to the borehole side walls. Should the type of rig, and/or equipment prove inappropriate for the requirements or conditions on site, these shall be replaced by suitable equipment at the Contractor's cost.

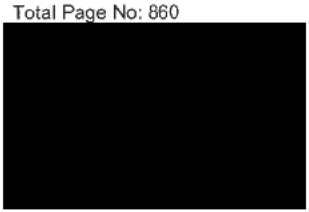
Before installation, piezometer tips shall be soaked in de-aired water for at least 24 hours. After installation the piezometers shall be completely flushed with de-aired water or as per manufacturer's specifications for preparation. The installation method to be employed will be dependent on the equipment type and manufacturer's specifications for installation as well as the site-specific circumstances. A typical approach would be as follows:

(i) Lower porous tip into position, about 200mm from bottom of hole

(ii) Pour a sand : water mixture down until tip is covered to a depth of about 300 mm. The sand shall have a D10 of between 0.1 and 0.7mm.

(iii) Seal off sand layer with bentonite pellets tamped lightly using a ring punner.

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(iv) Seal remainder of borehole by pouring down a cement:bentonite grout (typically 4 parts bentonite with 8 to 12 parts water and 1 part CEM II cement).The cement-bentonite grout should form an impermeable seal with the surrounding material and prevent the relieving of the pore water pressure at depth to that of the surface.

A method statement detailing the installation procedure, including the programming of the borehole drilling during the embankment excavation sequence as well as the proposed grout mixture, shall be supplied for approval by the Employer's Agent. Alternative methods of installation may be proposed. The saturation of the pressure cells to ensure that all air is expelled from the filters during placing shall be carefully maintained and monitored.

The Contractor shall exercise great care during construction of the dam embankment to ensure that the equipment and cabling etc. is not disturbed or damaged in any way. Cables shall be placed in backfilled trenches below the top layer of fill at all levels during construction of the dam embankment, and clearly marked and protected from damage by construction equipment and vehicles.

The recorder for the piezometers shall be installed at a single location in a weatherproof box. All cables from the piezometers shall be connected to this location. A suitable position of the monitoring terminal, outside of the footprint of the permanent works, shall be chosen and approved in consultation between the Contractor and Employer's Agent as part of the construction methodology development.

5.3.3 Testing, Surveying-In and Measurements

Each individual instrument shall be tested and calibrated before installation and its function and cable connection shall be tested immediately after installation to ensure proper functioning of the instrument before it is finally buried or grouted.

Immediately after installation the exact position of each piezometer shall be determined by accurate survey and the co-ordinates and levels calculated to an accuracy of 10 mm. This data shall be reported to the Employer's Agent immediately in writing.

The Contractor shall measure the pore water pressure recorded by the instrument at daily intervals or as otherwise directed by the Employer's Agent starting on the day following the installation of the instrument.

The pore water pressure shall be measured by means of a portable measuring device which shall be connected to a PC with relevant software for data evaluation. Software shall be capable of converting units to standard metric units. This device and its ancillaries shall be handed over upon completion of the works.

The taking of measurements shall continue until the issue of the Taking-Over Certificate.

5.4 SUBSURFACE LEAKAGE DETECTION SYSTEM

5.4.1 General

The reservoir will be fitted with a leakage detection system, as indicated on Drawings 1001757-2000-DRG-CC-2530 & 2531. The system is a drainage system under the reinforced concrete lining of the reservoir. Immediately under the concrete lining is a layer of no-fines concrete (NFC) to capture flow. Slotted pipes are embedded in the NFC and drain towards the subsurface gallery. The points at which these pipes enter the gallery are numbered and discharge into collection buckets for volumetric measurement of leakage. The details of the pipes, layers, dimensions are as indicated on the Drawings.

The NFC and pipes are arranged to delineate the reservoir basin into 26 compartments for independent identification and measurement of leakage from these compartments of the reservoir basin, as indicated on Drawing 1001757-2000-DRG-CC-2530. These zones are isolated by mass concrete strips in the NFC.

The leakage detection system is isolated from potential groundwater infiltration by a HDPE liner underlying the NFC. This HDPE liner is as detailed in Specification SPE-CC-003.

Below the HDPE liner is the Sand filter drainage layer as specified in the SANS 1200DE amendments.

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5.4.2 Type of instruments and installation

All the materials, dimensions, locations and other specifications are indicated on the drawings.

Each exit point in the gallery shall be clearly marked with the unique identification alphanumeric number of the compartment it is draining. This shall be indicated by an inscribed plaque on the wall affixed adjacent to the exit point.

An A2 landscape (page size) inscribed plaque, showing the outline of the drainage system with its individual compartments as well as the underdrainage pipes and their connection to the gallery (layout supplied by Employer's Agent), shall be mounted on the wall of the gallery at the point where the entrance gallery meets the main gallery. It shall be suitably lit.

5.4.3 Testing, Surveying-In and Measurements

The drainage outlets shall be individually monitored volumetrically on an hourly basis during the first filling of the reservoir also taking careful note of the water level in the basin at the time of the measurements. Measurements will then be taken daily during the waterproofing testing period. Upon instruction of the Employer's Agent the measurements may then be taken on a weekly basis. All measurements will be converted to a ℓ/min value and recorded together with the water level in the reservoir and rainfall (in mm) in the previous 24 hrs.

5.5 LEAKAGE MEASUREMENT WEIRS

5.5.1 General

The Contractor shall install leakage measuring weirs in the two outlet chambers as indicated on the relevant Drawings for the outlet chambers. The purpose of the weirs is to measure leakage water from the reservoir.

5.5.2 Type of Instruments and Installation

The specifications and locations of each measurement weir shall be as shown on the Drawings.

The seepage measurement weir shall consist of a forebay, a steel plate, cut to form a 90° V-notch, installed in the concrete chamber as shown on the Drawings. The V-notch shall have sharp edges to accurately measure the overflow. The plate shall be fitted with a ball valve at its base, at least 500 mm below the bottom of the V-notch, to drain the forebay during maintenance.

The Contractor shall furnish and install a manual water level indicator on the upstream face of the concrete structure as detailed on the Drawings. After all drilling and cutting has been completed, the mild steel indicator gauge plate shall be finished on both faces by a vitreous porcelain enamel surfacing. Graduations shall be clearly painted in divisions of not more than 1 mm onto the enamel face of the gauge in a format to be agreed by the Employer's Agent. The plate shall be precisely levelled and fixed to the concrete structure such that the readings are relative to the level of the apex of the V-notch. The fixing shall allow for vertical rotational adjustment for calibration during installation and future adjustments.

In addition, the level of water within the concrete structure shall be remotely monitored by an electronic water level sensor as specified in the Electronic Specifications.

The downstream chamber from the V-notch shall be fitted with an overflow pipe as well as a sump pump as indicated on the Drawings.

5.5.3 Testing, Surveying-In and Measurements

Immediately after installation the position and level of each V-notch weir shall be determined by a survey. This data shall be reported to the Employer's Agent immediately in writing.

Daily measurements of the seepage water shall start as soon as any flow over the weirs is detected and shall continue until the issue of the Taking-Over Certificate.

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5.6 RESERVOIR WATER LEVEL GAUGES

5.6.1 General

The reservoir water level will be monitored using three independent systems of measurement; two automatic electronic sensors as detailed in the Electronic Specifications, and one manual gauge plate. In addition, full supply level (FSL, i.e. the spillway overflow level) and maximum overflow level (FSL +0.4m), as well as 20%, 40%, 60% and 80% full (by volume), will be indicated by paint markings on the vertical and sloping concrete walls and faces inside the reservoir. These paint markings can be spaced at 25 m intervals. The Employer's Agent can provide the relevant elevations for these markings upon request.

5.6.2 Type of Instruments and Installation

The water gauge plate shall consist of several staggered a mild steel plates fixed to the concrete columns and the external perimeter wall at the north-eastern entrance to the reservoir basin. The gauge plates shall be staggered such that the water level can be easily read by standing on the nearby stairs. Therefore, the higher levels shall be located further up the slope and the plates indicating the lower levels further down the slope.

The plates shall be 130 mm in width which shall be finished by a vitreous porcelain enamel surfacing. Graduations in divisions of 10 mm shall be clearly painted onto the enamel face of the gauge plate. The gauges shall extend from the floor level to the maximum overflow level 0.4 m above the FSL.

5.6.3 Testing, Surveying-In and Measurements

The installation of the level recording equipment and the level indicator gauges require to be installed with the aid of precise levelling by a registered land surveyor.

The manual level recorder will be used to calibrate the other water level sensors.

Recording of the water level shall start as soon as the water level rises above the lowest level of the instrument and the readings shall be performed twice daily or as directed by the Employer's Agent. All three readings (from the three instruments) shall be taken at roughly the same time.

5.7 BOREHOLE STANDPIPES

5.7.1 General

For observation of the groundwater level in the terrain surrounding the dam, borehole standpipes shall be installed in the locations as shown on the Drawings or directed by the Employer's Agent. At least one of these may still exists as drilled during the geotechnical investigation. Due to their location several of the boreholes can only be installed at the completion of Stage 4 of the excavation and embankment placement sequence.

The requirements of this Specification include all rotary core drilling of boreholes in the terrain, supply of pipes, fittings, filter material, sealing material and concrete protective header chamber including seals and locks and all associated concrete works.

5.7.2 Type of Instruments and Installation

All materials and works shall be in accordance with the relevant Clauses of this Specification.

The borehole standpipes shall be installed to a depth of 6 m, 10 m, or as directed by the Employer's Agent. These boreholes shall be rotary core drilled in the overburden to a minimum diameter of 102 mm. The equipment shall consist of a 1 m long perforated pipe casing and a non-perforated casing, the length of which is selected to suit the depths of the borehole in the overburden, a closed ended length of pipe, a pipe set into a lean concrete surface slab on the head, and a lockable hinged cover. A non-perforated sump section of at least 0.5 m length between the perforated section and the closed bottom of the piezometer tube shall be provided. If a gap between the bottom of the piezometer pipe and the bottom of the hole is required, this depth of hole shall first be filled with filter material.

The perforation of the filter section may be provided by holes with a diameter smaller than 5 mm or by slots

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with an opening width of less than 3 mm as approved by the Employer's Agent. The perforated section of the casing shall be wrapped with a geotextile which is fixed with a plastic cord.

The top of the casing pipe shall be fitted with a lockable tightly sealing hinged cap which can be lifted for normal dipping. The cap shall be fully watertight but shall under all circumstances permit free aeration of the borehole.

Electrical dip meters which indicate the contact with the water surface by means of both a light and an audible signal shall be provided. Each shall have a calibrated suspension meter tape, connected to the electric cable, which is capable of measuring the water level or head of water to ± 10 mm. A dip meter with a tape length of 30 m shall be provided.

5.7.3 Testing, Surveying-In and Measurements

Immediately after installation the exact position of each standpipe and the level of the reference point at the top of the protruding pipe and the bottom of the borehole shall be precisely surveyed. The co-ordinates and levels shall be calculated to an accuracy of 10 mm, and this data reported to the Employer's Agent immediately in writing. The elevation of the top of the pipe shall be marked/engraved on/into to the cap of the borehole. The depth to the water level can then be measured from this surveyed level and referenced to the other readings.

The Contractor shall measure the water level in the completed borehole at intervals of 24 hours or as directed by the Employer's Agent starting on the day following the installation of the borehole. The zero measurement of the water level shall be performed before the impoundment of the reservoir. The water level shall be measured by means of the dip meter described above.

Water level measurements shall continue at each borehole until the issue of the Taking-Over Certificate.

6 MEASUREMENT AND PAYMENT

6.1 BASIC PRINCIPLES

The rates shall cover the cost of supplying the specified or scheduled items or systems, complete as indicated on the drawings, and as specified above. It shall include the cost of all fixings, connections, installing/fixing, grouting/casting in, etc. The rate shall further include for all procurement costs, transportation, all plant, labour and materials necessary for proper installation, and operation.

The rates tendered against the items in the Bill of Quantities shall include for full compensation of all costs incurred in supervision and testing of the installations including the provision of all labour, equipment, transport, materials and temporary works necessary to perform on-site quality assurance and quality control, inspection and testing of the unit in accordance with the Specifications.

The cost for initial survey and precise levelling of the equipment as specified, by registered surveyor, will be included in the scheduled costs as described below. Costs for subsequent monitoring during construction will be scheduled separately.

6.2 SETTLEMENT BEACONS ON RESERVOIR EMBANKMENT CREST ..... Unit: No

Measurement shall be by the number of beacons installed complete as specified and indicated on the drawings. It shall also include the survey as specified.

6.3 SETTLEMENT PINS ON RESERVOIR ROOF ..... Unit: No

Measurement shall be by the number of pins installed complete as specified and indicated on the drawings. It shall also include the survey as specified.

6.4 SURVEY REFERENCE BEACONS ..... Unit: No

Measurement shall be by the number of survey reference beacons installed complete as specified and indicated on the drawings. It shall also include the survey as specified.

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6.5 PIEZOMETERS IN FOUNDATION ..... Unit: No

Measurement shall be by the number of piezometers installed. Separate items shall be scheduled for piezometers:

a) up to and including 5 m depth

b) Above 5 m and below or equal to 10 m depth and

c) Deeper than 10 m

The rates tendered against the items shall include for full compensation of all costs incurred in the manufacture, procurement, inspection, testing, protection, all necessary manuals (instruction manuals, data sheets and calibration certificates etc.), packaging, delivery to site and installation of the specified instruments and equipment in accordance with the Specification.

The rates shall include setup and all costs related to scheduling, drilling, redrilling where necessary, casing and fittings for the depth of the hole, backfilling/plugging as specified and finishing.

Payment will be made per unit. Payment will only be effected after full compliance of the items with the Specifications has been certified by the Employer's Agent. Payment of the monitoring and reporting shall be compensated under 6.11 below.

6.6 BOREHOLE STANDPIPES..... Unit: No

Measurement shall be by the number of borehole standpipes installed.

The rate shall include for all costs related to scheduling, setting out, setting up, drilling, redrilling where necessary, casing and fittings for the depth of the hole, detailing as specified and finishing.

The rate shall include for all costs related to capping of the borehole, surveying, labelling, instruments, tapes and fittings for the depth of the hole and finishing as specified.

6.7 SUPPLY, INSTALLATION AND PROTECTION OF INSTRUMENTATION CABLING .....Unit: m

Measurement will be the length of instrument cabling installed in the embankment and foundation, as shown on the Drawings or as directed by the Employer's Agent.

The length measured shall be the length of two pair cable supplied and installed. Where multiple core cables are used the total length of two pair (four wires) shall be measured and paid for. The rate shall include all junction boxes and protective measures including lightning protection, screening and armouring.

The rate tendered shall include for the excavation of trenches, selection, supply and placing of the backfill material, and other resources required to form the protective surround of sand or fine-grained material around the instrumentation cabling in the trenches excavated and shall include for full compensation for all labour, ancillary equipment, materials, signage and other protection measures, and time delays not covered above.

6.8 SUBSURFACE LEAKAGE DETECTION SYSTEM MISCELLANEOUS .....Unit: N/A

The leakage detection system shall be measured and paid for by individual rates as scheduled. Items for the pipes, pipes couplers, no-fines concrete, bedding, interfaces and penetrations are scheduled in the Structures bill.

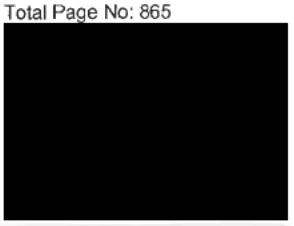
Items for the other miscellaneous items: collector buckets, brackets supports, identification and layout plaques are scheduled in the Embankment Monitoring bill.

6.9 LEAKAGE MEANSUREMENT WEIRS..... Unit: No

The leakage measurement weirs shall be measured and paid for by individual rates as scheduled.

The rate tendered against the item in the Bill of Quantities shall include for full compensation of all costs incurred in the manufacture, procurement, inspection, testing, corrosion protection and installation, of the steel plate V-notch weir, ball valve, and a stainless-steel indicator gauge plate finished and graduated and calibrated as specified.

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Payment will be made per complete unit. Payment will only be effected after full compliance with the installation and calibration has been certified by the Employer's Agent. Payment for the concrete, formwork, reinforcement, gratings/covers, access, overflow, pipes and electronic instrumentation, will be measured separately in accordance with the relevant Sections.

6.10 MANUAL RESERVOIR WATER LEVEL GAUGES..... Unit: Sum

The rate tendered against the item in the Bill of Quantities shall include for full compensation of all costs incurred for the gauge plates and internal markings as specified, including surveying-in.

Payment will only be made after full compliance with the installation and calibration has been certified by the Employer's Agent.

It is noted that the electronic water level equipment is not measured here and will be dealt with as described in the Electronic Specifications and measured as described therein.

6.11 MONITORING AND REPORTING DURING CONSTRUCTION ..... Unit: Sum

The Sum will be paid for as a lump sum 50% on first measurement reporting of all instruments and 50% at the end of the Defects Notification Period provided that the Employer's Agent is satisfied that all duties have been satisfactorily complied with.

The rate tendered shall include for full compensation of all costs incurred in monitoring, taking of readings and reporting results to the Employer's Agent during construction, the filling period of the dam and operation of the dam during the Defects Notification Period.

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[redacted]

SPECIFICATION: SPE-MM-0001

Design, Supply and Installation of HVAC Systems

[redacted]

SPECIFICATION: SPE-MM-0001

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[redacted]

1. DEFINITIONS AND ABBREVIATIONS

The following terms shall, unless the context otherwise requires, have the meanings hereunder assigned to them:-

'Approved' 'accepted' or 'directed'	As approved, satisfactory, accepted or directed as satisfactory by the Architect.
'Balancing'	Work adjustments and checks necessary to proportion the flow within the distribution system (sub-mains, branches, terminals) in accordance with specified design quantities.
'Commissioning'	Work necessary to place the installation and work covered by this specification into normal operating condition.
'Concealed'	Embedded in masonry or other construction, installed in furred spaces within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
'Exposed'	Not installed underground or concealed as defined above.
'Indicated' specifications.	As indicated, shown or noted as shown on drawings and/or
'Install'	To erect, mount and connect complete with all related accessories.
'Provide' operation.	To supply, install and connect up complete and ready for safe
'Similar' or	Of approved manufacture equal as regards to 'equal' materials, weight, size and efficiency of performance to product specified by name.
'Supply'	To purchase, procure, acquire and deliver complete with all related accessories.
'Testing'	Work and checks necessary to determine qualitative and quantitative performance of equipment, installation and workmanship.
'Wiring'	Conduit, fittings, wiring, junction and outlet boxes, switches, cut-outs and socket outlets and all related items.
'Work'	All labour, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

Abbreviations used in these documents shall means :-

'ASIB'	Automatic Sprinkler Inspection Bureau
'AFI'	Air Filter Institute
'AMCA'	Air Moving and Conditioning Association
'ASA'	American Standard Association
'ASHRAE'	American Society of Heating, Refrigeration and Air Conditioning Engineers

'ARI'	Air Conditioning and Refrigeration Institute (USA)
'ASME'	American Society of Mechanical Engineers
'ASTM'	American Society of Testing Materials
'AWWA'	American Water Works Association
'BSS'	British Standard Specification
'BSI'	British Standard Institute
'BS CP'	British Standard Code of Practice
'CIBS'	Chartered Institution of Building Services
'DIN'	German Standards Institute
'HVCA'	Heating and Ventilating Contractor's Association (UK)
'NBFU'	National Board of Fire Underwriters (USA)
'NBS'	National Bureau of Standards (USA)
'NEMA'	National Electrical Manufacturers Association (USA)
'NFPA'	National Fire Protection Association (USA)
'SABS'	South African Bureau of Standards
'SMACNA'	Sheet Metal and Air Conditioning Contractors National Association, Inc (USA)
'UL'	Underwriters Laboratories

2. COMPLIANCE WITH REGULATIONS AND STANDARDS

It shall be the responsibility of the Sub-Contractor to ensure that all equipment and methods used in the installation, comply with all relevant statutory regulations, and amendments thereto in particular the following :-

S.A.N.S. Code of Practice 10142, as amended, for the Wiring of Premises.

The Occupational Health & Safety Act of 1993, as amended.

Government, Provincial and Local Authorities Ordinances, Regulations, By-laws, Rules and other Statutory requirements.

Specifications and Codes of Practice issued by the South African Bureau of Standards and British Standards Institute. The former shall have precedence over the latter where both bodies have issued conflicting specifications or codes of practice.

The Sub-Contractor warrants the software contained in the equipment or systems that the Sub-Contractor provides for use by the Employer shall include, at no additional costs to the Employer, design and performance features and capabilities to ensure that the software will not be inaccessible and that the software will not provide invalid or incorrect results.

3. STORAGE OF MATERIALS

Materials shall be stored in areas allocated by the Main Contractor. Stored material shall be safely stacked and shall not overload floor construction beyond design limits.

4. ACCESSIBILITY

Equipment shall be installed so as to be readily accessible for testing, operation, maintenance and repair. Minor deviations from drawings may be made to accomplish this, but changes of magnitude or which involve extra costs shall not be made without approval of the Architect.

Platforms and ladders shall be provided where indicated for access to instruments and equipment in accordance with the requirements of authorities having jurisdiction.

All platforms shall have removable gratings, toe plates, and guard rails and shall be of riveted or welded structural steel with supports cross-braced on all four sides and welded to baseplates. The baseplates to be anchor bolted to concrete piers.

All ladders shall be of structural steel and suitably supported, and shall have minimum dimensions of 0,5 m width with 65 mm by 65 mm side rails and 30 mm diameter rungs.

5. SUPPORTS FROM OVERHEAD CONSTRUCTION

Where overhead construction does not permit fastening of supports, additional approved framing shall be provided.

Duct and pipe support brackets shall be firmly fixed to overhead construction by an approved system. "Shotfiring" of supports into concrete will not be accepted.

[redacted]

6. IDENTIFICATION

All identification shall be legible, and shall be painted or fixed after completion of final finishes. Identification colours shall be in accordance with BS 1710 and/or as instructed or approved by the Architect.

Labels

A label shall be provided under each gauge, meter, instrument, pilot lamp, remote control switch, motor controller and panel mounted item and equipment identifying the equipment controlled by such items.

The labels shall consist of non-corroding material TRAFFOLITE with non-glossy appearance, engraved, block on a white background. All labels shall be of the screwed-on type.

Valve Tags and Charts

Aluminum numbered tags including letters to identify the system, shall be fastened by heavy brass chain to all valves indicated on the drawings.

The metal tags shall be 50 mm in diameter and 1 mm thick, and shall have stamped-in numbers and letters.

The Sub-Contractor shall be responsible for submitting a list of all valves and controls, giving location and function, together with diagrammatic charts featuring each piping system with valves and controls, identified by numbers and letters shown on the corresponding tags.

Piping

In addition to painting of external surfaces (including insulation), colour coded polyvinyl chloride bands shall be applied to pipes identifying their content and direction of flow.

Bands shall be provided to piping at valve locations, at points where piping enters or leaves a partition, wall, floor or ceiling and at least at every 10 m centres of straight runs. Where piping is concealed, bands shall be applied to valves or other devices whenever access is provided by doors or panels. Exit and entrance points to each vessel, tank or place of equipment shall be identified by bands. Insulated pipes shall be banded after insulation and painting work has been completed.

The band's width shall be minimum 200 mm wide for pipes up to 250 mm diameter and 400 mm wide for larger diameter piping. The pre-printed letters on band, identifying the services shall be of at least 20 mm high.

Piping of less than 25 mm nominal bore need not be colour banded but shall be painted all over with the identifying colour of its content.

Ductwork

All ductwork shall be identified by writing in words the service of the duct and by pointer showing the direction of flow. Markings shall appear at least at the point of origin and whenever ducting enters or leaves walls, floors or ceilings and for every 20 m centres of straight lines.

The identification letters shall be at least 50 mm high and the flow arrow 150 mm long.

Access Panels

Approved ceiling tile markers shall be provided in areas where removable ceilings or

[redacted]

access panels are positioned to indicate the location of valves and/or other devices.

Colour Schedules

Unless otherwise indicated, the following colour schedules shall apply.

Note 1

All equipment, ducts, pipework, metal parts and insulated and plastered surfaces shall be throughly descaled, cleaned and painted with a priming coat and two coats of oil paint.

Note 2

Paint shall be of the highest quality super enamel as manufactured by Plascon or equal, and shall be applied strictly in accordance with the manufacturer's recommendations and directions Colour derived from PLASCON COMPUTACOLOUR are denoted (c.c.)

Note 3

All colour bands shall be 250mm long. In cases where banks of parallel pipes runs occur, the colour bands shall be of a uniform length and grouped together wherever possible.

Note 4

Colour bands, where specified or exposed services shall be applied at all entries to junctions, connections to appliances, bulkhead and wall penetrations and both sides of valves.

Bands shall be at 3 000mm centres on straight sections.

Note 5

Colour bands, where specified or concealed services shall be applied to all access points to ducts, shafts, ceilings, etc.

Note 6

In concealed accessible areas, the banding shall be applied to pipework or trunking at 2 000mm centres.

Note 7

Where chilled water, hot water or domestic hot water is clad with sheetmetal, it is to be painted continuously. Where unclad, it is to be banded.

PIPING - AIR CONDITIONING

Chilled Water flow and return	Midnight Blue G.116	Continuous	Continuous	-
Chilled water F & E	Midnight Blue G.116	Continuous	Continuous	-
Condenser water flow & return	Magic Green G.408	Continuous	Continuous	-
Condenser water F & E	Magic Green G.408	Continuous	Continuous	-
Computer boosted water supply	Sunlight yellow G.12	Continuous	Continuous	-
Treated water	Verda 9 (c.c.) M-37-4	Continuous	Continuous	-

Drains	Black G.2	Continuous	Continuous	-
Refrigerant (hot gas)	Copper Polish and Varnish	Continuous	Continuous	-
Refrigerant (liquid)	Copper Polish and Varnish	Continuous	Continuous	-
Refrigerant (suction)	Everest Grey G.71	Continuous	Continuous	-
Bleed water	P.W.D. Brown G.18	Continuous	Continuous	-

7. SOUND AND VIBRATION CONTROL

The Sub-Contractor shall be responsible for the rectification of any excessive noise and/or vibration caused by the operation of the air conditioning and ventilation system installed under this sub-contract.

The Sub-Contractor shall be responsible for the detail design of concrete inertia blocks, if required or specified, but such blocks will be provided by others.

Each vibration isolation system shall be designed for a static deflection factor necessary to give maximum transmissibility as scheduled below :-

Maximum Permissible Transmissibility

PLANT/FOUNDATION/TYPE	ON SOLID	SUPPORTED FROM GROUND	SUPPORTED FROM STRUCTURE IN OCCUPIED AREA
Axial fan up to 7,5 kW incl. Centrifugal fan up to 4 kW incl. Centrifugal pump up to 4 kW incl.	50%	25%	5%
Axial fan 7,5 - 40 kW incl. Centrifugal fan 4 - 20 kW incl. Centrifugal pump 4 - 11 kW incl. Reciprocating compressor 7,5 - 40 kW incl.	30%	10%	3,5%
Axial fan over 40 kW incl. Centrifugal fan over 20 kW incl. Centrifugal pump over 11 kW incl. Reciprocating compressor over 40 kW	30%	3,5%	5%
Pipes *	10%	10%	10%

*Pipes up to 75 mm bore only if needed.

The sound control system shall provide for noise levels specified under the relevant clauses in Part V of the specification.

Isolation of Mechanical Equipment

All equipment shall, wherever possible, be orientated in such a way that maximum sound radiation patterns are directed so as to cause least disturbance. (Maximum sound radiation occurs in the direction in which fluid enters and leaves the equipment)

All rotating machinery shall be balanced. The critical speed shall be at least 20% above the operating speed.

Vibration isolation mountings shall be provided for all equipment. Mountings shall be installed in accordance with the manufacturer's instructions. However, the Sub-Contractor shall be responsible to ensure that amplitude of motion and vibration transmission will not exceed the specified limits.

Floor mounted equipment shall be erected on a concrete plinth, which shall protrude at least 25 mm above finished screeded floor level.

Isolators shall be selected to give both horizontal and vertical flexibility (compression and shear). The amplitude of motion due to operation of the supported equipment shall not exceed 3 mm.

Spring isolators shall be designed and installed in such a way that the ends of the springs are constricted to remain parallel during deflection. For stability, the outside diameter of springs shall be at least equal to their compressed height at rated load. Springs shall have a minimum additional travel to solid, equal to 20% of the rated deflection. Each spring mounting shall be set on 7 mm thick neoprene acoustical pads.

Suspension type supports, i.e. springs combined with suspension rods, shall be rendered dynamically damped where necessary, by the provision of suitable dynamic dampers (dashpots) arranged diagonally or onto vertical building faces.

Isolation of Piping and Ducts

All connections to equipment shall be sufficiently flexible to prevent excessive strain to allow the equipment freedom to move and to prevent plant vibration being conducted. Initially, special flexible connections may be omitted in a piping system and use shall be made of natural flexibility of resilient hangers or mountings for vibration isolation. However, flexible connections shall be inserted and other necessary adjustments shall be made, at the Sub-Contractor's expense, should the need arise.

All ductwork and piping within 15 m from connected vibration-inducing equipment shall be hung on resilient hangers. The first four hanger supports shall be capable of supporting piping at a fixed elevation during installation and, in addition, shall have a secondary adjustment to transfer the load to the spring element within the mounting, after the system has been filled with water.

The Sub-Contractor may be required to disconnect the piping after the installation is completed to demonstrate that no strain is exerted at the connections to the equipment.

Noise suppressors shall be installed downstream of all steam pressure reducing valves.

Where piping and ductwork passes through walls, floors or ceilings or plantrooms, acoustical seals shall be employed to confine airborne noises to the inside of such rooms.

Sound Attenuation

Sound attenuating units or treatment shall be provided as indicated and/or required to control the noise from air conditioning and ventilation systems to within the limits specified. Noise levels caused by the equipment shall not exceed the ambient noise levels by more than 7dB in each frequency on the site boundary.

It should be noted that the provisions for sound attenuation shown the Engineer's drawings (or the absence of same) are based on average published data for equipment noise and inherent attenuation. The Sub- Contractor shall, nevertheless produce his own calculations for noise levels in the areas specified, and provide additional silencing equipment and/or treatment if necessary.

To minimize the need for sound attenuation, fans shall be selected to operate near their

maximum efficiency point when producing the required air quantity and static pressure.

Sound attenuators and acoustic treatment in ducts shall be proof against fire, fungus and erosion and not produce dust or come loose.

"Packaged" attenuators shall normally be flanged for bolted connections, and flexible duct connectors shall be used as shown or required.

Attenuators shall have an air resistance not exceeding 75 Pa measured at sea level at maximum air quantity.

Noise Measurement

The Sub-Contractor shall submit sound pressure levels measured on the completion of the installation, detailing the sound pressure levels in dB (re: $2x10^{-5}$ Pa), for the seven International Standard Octave Bands measured by means of a sound meter in at least six (6) areas within the building, as selected by the Architect.

Measurements for sound pressure level data shall be taken by the Sub-Contractor, or at his expense by an approved organization, under full or nearly full cooling and air flow conditions.

Noise level in the conditioned space through the operation of the unit at any operation point shall not exceed the specified internal, NC level with an 8 db room attenuation factor in each octave band. Due allowance shall be made for all attenuators required to meet the specified noise levels whether shown on the drawings or not. Operating of the unit shall not cause noise levels in the surrounding areas to be more than 7 db, in each frequency, above ambient noise levels at any boundary of the site.

8. INSULATION

All piping and ducting shall be insulated as specified below.

All insulation of piping, ductwork and equipment shall comply with BS 5970, provisions of BS5422. Test reports may be requested from an approved testing laboratory, at the Sub-Contractor's expense, to certify the declared thermal conductivity under operating temperature of the chosen insulating materials.

Insulation shall be applied in accordance with manufacturer's general instructions in a neat and workmanlike manner so as to present a smooth and even surface. The insulation shall be compatible with the surface to be insulated and shall not demonstrate or cause any corrosion or stress corrosion under operating conditions. Vapour proofing and adhesives shall be compatible with the insulation; under no circumstances shall an adhesive or solvent be used which could attack or dissolve the surface or material of the insulation.

Covering which is subject to abrasion during normal maintenance shall be protected by perforated sheet metal with corners and edges of insulation being returned by formed angles fixed to panel edges inside the casing. Covering which may be splashed with water under operating conditions shall be suitably protected and drained to waste.

Piping, ductwork or equipment shall be clean, dry, free from grease, rust and scale and shall be tested and approved for tightness and workmanship prior to application of insulation. Insulation shall be continuous through sleeves, wall and ceiling openings.

Materials and Finishes

Any insulation material and their finishes used shall resist rotting, fire, decay, fungus growth, attack by vermin or erosion, thermal or acoustic, whichever may occur under

operating conditions.

The thickness of insulation, unless otherwise specified, shall conform with the following dimensions for the various normal application :-

THERMAL CONDUCTIVITY W/m°C	APPLICATION:	PIPING		
	TEMP. LIMITS:	4 - 100 °C	4 - 100°C	DIRECT EXPANSION SUCTION
	SIZE:	MAX 80mm dia	80-500 mm dia	
≤ 0,035		25 mm	50 mm	40 mm

Piping Insulation Material shall be as follows:

Piping > than 100mm (Outside Building): Mylar foil covered polystyrene – Bends insulated with fiberglass rope and wool materials, supercoated with a 12mm thick layer of insulpro hardsetting insulation plaster and finished with a gauze reinforced vapour barrier.

Piping > than 100mm (Inside Building) : Mylar foil covered fibreglass – Bends insulated with fiberglass rope and wool materials, supercoated with a 12mm thick layer of insulpro hardsetting insulation plaster and finished with a gauze reinforced vapour barrier.

Piping < than 100mm: Elastrometric Armaflex.

All external (exposed to rain and sunlight) piping and all piping up to 3m high or where shall be cladded in GSM.

Ducting Insulation Material shall be as follows:

External insulation	:	25mm fibreglass
Density	:	16 kg/m ;
Conductivity	:	0,045 W/mK
Vapour barrier	:	Foil reinforced Kraft
Fixing	:	Pinned and strapped
Internal insulation	:	Fibreglass with sonic liner
Inside Building	:	25mm
Outside Building	:	50mm
Density	:	16 kg/m ;
Fixing	:	Mechanically fixed and pinned.

Where specified thickness of insulation exceeds commercially available sizes, insulation in two or more layers, with all joints staggered, shall be applied. Overlaps shall be at least 50 mm.

To ensure that the correct thickness of insulation and covering has been applied, the Sub-Contractor shall, if required to do so, cut one or more section from the finished insulation. If deficiencies are revealed, the Sub-Contractor shall, at his own expense, remove the whole and provide and fix the correct insulation.

Fire Hazard Ratings

Satisfactory test results from the National Building Research Institute or test reports from an approved testing laboratory may be required, at the Sub-Contractor's expense, to certify the fire hazard ratings for proposed materials for insulation, covering and vapour sealing do not exceed those specified.

[redacted]

Such Building Research Institute of the South African Council for Scientific and Industrial Research, and in accordance with test procedures BS 476.

Insulating materials, finishes, vapour barriers and adhesives shall conform to the fire hazard ratings specified as follows:-

- The fuel contribution index shall not exceed O when compared with asbestos taken as O.
- The smoke contribution index shall not exceed 10 when compared with hardboard taken as 100.
- The spread of flame index shall not exceed 0 when compared with asbestos taken as 0.

Any productions of combustion of said materials shall be completely non-toxic and non-corrosive.

Piping and Fittings

Unless otherwise specified or noted, the following piping need not be insulated :-

Vent, overflow, drain and relief piping; pneumatic control air piping; cold water make-up piping; water treatment piping; condenser water piping.

All cold piping (chilled water, refrigerant suction) and all steam, condensate and hot water circulating piping shall be insulated, using rigid performed sections having a bore to suit the pipe.

The insulation shall be externally covered. The covering to insulation on cold piping shall form a complete vapour barrier as specified below.

Covering of insulation which is visible but not readily accessible shall be finished neatly, and painted. Where the covering used, as specified above, is not suitable for the purposes, hard setting compound shall be applied, trowelled true and smooth, and painted.

Insulation in plantrooms and enclosures and insulation which is visible and accessible, i.e. up to 2,5 m above floor level shall, in addition to the covering specified above, be neatly enclosed in metal casings made out of aluminium or galvanised steel of at least 0,8 mm thickness or covered with 12 mm thick minimum hard setting compound, reinforced by galvanised mesh.

Insulation of piping exposed to the weather shall be metal cased as specified above, and this casing shall be lapped so as to be rainproof. Casing shall be painted.

Self-tapping screws, or blind rivets, the application of which could damage the vapour sealing, shall NOT be used for fixing metal casings to vapour sealing.

Rigid preformed piping insulation shall be applied, wherever possible, for the insulation of bends, tees, elbows, flanges and valves. Where pre-formed pipe insulation is not possible to use, blocks or batts shall be securely wired or banded in position and all joints and voids shall be filled with mineral wool.

Alternatively, the Engineer may permit the use of foamed-in-situ insulation inside metal casings applied to such special positions.

Where practically possible, piping shall be supported OUTSIDE the insulation or cradles as specified below. Where the load on the insulation exceeds the strength thereof, a suitable part of the insulation shall be replaced by material having higher crushing strength. Normally, dry hardwood will be acceptable for this purpose.

[redacted]

Where insulation is specified for piping, the same shall apply to all fittings and pipe connections within the system.

Ductwork

Unless otherwise specified or noted, the following ductwork need not be insulated:-

Return air ductwork; exhaust air ductwork; supply ventilating systems except when incorporating heating.

Unless otherwise specified or noted, insulation shall be applied to the outside of the duct.

Concealed ductwork shall be insulated with rigid or flexible materials. Flexible materials shall have a density of at least 16kg/m ; .

Ductwork which is exposed and visible but not readily accessible shall be insulated with rigid material having a facing of aluminium foil or hard setting cement finished smooth and true, and painted.

Ductwork in plantrooms and ductwork which is exposed, visible and readily accessible, i.e. up to 2,5 m above floor level, shall be insulated with rigid material and protected against mechanical damage either by aluminium sheet of at least 0,8 mm thickness or be reinforced hard setting compound of minimum 12 mm thickness, and painted.

Ductwork insulation exposed to atmospheric conditions shall be covered by galvanised sheetmetal panels soldered and lapped so as to be weatherproof, and painted.

Self-tapping screws, or blind rivets, the application of which could damage vapour sealing, shall NOT be used for fixing metal casings.

Where insulation is fixed to the inside of the ductwork, the surface treatment of such insulation exposed to the air flow shall resist shredding and erosion, and where such insulation is adjacent to humidifiers, air washers or cooling coils; the surface shall have water protection.

The insulation shall cover flanges by means of boxes or by increasing the thickness of insulation to give at least a 6 mm cover at these points.

Fans

Fans handling cooled or heated air, and externally subject to ambient temperatures, shall be insulated on all exposed surfaces with a semi-rigid material cut to shape, covered with galvanised bird-wire held with welded pins at 300 mm centres each way and hard setting cement of at least 20 mm thickness.

The minimum insulation thickness shall be the same as specified for ducting.

Air Handling Units and Enclosure

Air handling units shall be insulated with rigid material on all exposed areas, held in place by pins and washers at 450 mm centres each way, and covered with sheetmetal panels.

Air handling unit enclosures, either being in metal, concrete or brick and containing cooled or heated air, shall be insulated.

Where possible, such insulation shall be on the inside of the enclosure, suitably retained and protected.

The minimum thickness of insulation shall be as specified above, for ducts.

[redacted]

For such internal insulation the enclosure will act as vapour seal for cooling plant, and the fabric of said enclosure shall therefore be treated as follows :-

a) Metal enclosures: all seams, rivet holes etc. sealed.

b) Masonry enclosures: internally coated with suitable bitumen emulsion.

Cooling Coil Sumps

Sumps shall be mounted on 25 mm thick insulation having a thermal conductivity of not more than 0,04 W/m ºC.

Alternatively, they may be internally lined with an equivalent thickness of foamed-in-situ plastic, internally moisture proofed.

Vapour Barriers

Insulation used on piping, ducting and plant, operating below ambient temperatures, shall be coated with a vapour barrier to be applied immediately after dry insulation has been fitted.

No chilled water, refrigerant, suction gas or cold air shall pass through insulated piping, ducting or equipment before vapour proofing has been applied.

Where insulation shall be removable, eg. at flanged joints, etc. the main insulation shall be stopped short of the fitting with the vapour barrier sealed to the shell. The removable portion of the insulation shall then be fitted as a separate item with its vapour barrier overlapping and sealed to the main vapour barrier. Attention shall be given that the vapour barrier and the insulation are not pierced or damaged by supports.

At discontinuities and at section ends, the vapour barrier shall be returned to the surface to prevent moisture from entering the insulation at the edges.

Where it is unavoidable to connect hangers, supports or anchors solidly to cold services, such hangers etc. shall be "feathered" with insulation, and vapour sealed, after the main insulation and vapour sealing has been applied, which later shall be carefully sealed onto the metal of the support.

At the point where the support is attached to the building fabric, insulation such as rubber or neoprene pads or bushes shall be provided to prevent invisible condensation and corrosion.

Piping vapour barrier shall be Mylar foil laminate.

9. INSTRUMENTATION

The equipment and/or sub-system supplier/assembler shall provide under the overall responsibility of the air conditioning sub-contractor, all permanently installed instrumentation necessary for logging and monitoring of status and performance of equipment and components.

In addition, a sling psychrometer shall be provided at handover for use by the Employer.

Hygrometers

Hygrometers shall have an accuracy of 5% in the range of 10% to 100% relative humidity.

10. EQUIPMENT SUBMITTAL

[redacted]

The contractor shall compile and submit three (3) booklets of the equipment selection and submittal to the Consulting Engineer within two weeks after appointment for approval.

The equipment submittal booklet shall consist of:

1. Cover page stating the project name, the client, the consulting engineer and the contractor with contact persons and details
2. The index page stating the contents and sections of the submittal with page numbers
3. General: a brief description of the project and the equipment offered
4. Introduction: brief history of the contractor, experience, personnel proposed for the project with brief CV and project photos where the equipment proposed was used.
5. Table of the equipment capacity of all equipment contained in the submittal showing the following:
    i. Design conditions
    ii. Equipment name and designation
    iii. Area served
    iv. Operating capacity
    v. Dimensions (length, width, height and weight)
    vi. Starting current, running current and voltage
    vii. Noise level
    viii. Compliance with specification
6. Detailed of the equipment offered (this section is to be repeated for every single item of equipment offered).
    i. General: name of equipment offered, previous project where equipment was used with reference from the client
    ii. The Equipment: all technical specifications, photos where applicable, service interval and estimated operating life in years of the equipment. The technical specifications as a minimum shall state:
        i. Capacities
        ii. Material of manufacture and type of finishes
        iii. Make
        iv. Model number
        v. Manufacturer details
        vi. Estimated delivery date
        vii. Noise levels
        viii. Operating conditions and performance curves where applicable
        ix. Compliance with specifications
        x. Electrical requirements and loading
        xi. Energy efficiency measures of the equipment offered
        xii. Any special sustainable design and details included in the equipment
        xiii. The completed schedule of information in the tender document
        xiv. Manufacturer's catalogues
        xv. Control system and electrical schematics for the equipment
        xvi. Any other relevant information
7. Motivation for the proposed equipment
8. Conclusion
9. Approval page for signature and date:
    i. The contractors name and responsible person signature
    ii. The consulting Engineers name and responsible person signature
    iii. The client's signature and responsible person
    iv. Approval stamp by consulting engineer.

[redacted]

11. TEMPORARY USE OF EQUIPMENT

No equipment which is part of the permanent installation shall be operated or used, during the course of construction without the written permission of the Architect.

12. QUALITY MANAGEMENT SYSTEMS

The sub-contractor shall ensure that an approved and appropriate quality management system is implemented for the manufacture of equipment and site installation of the systems.

13. Paints

Any paint used in an internal application, and applied on site, must meet the TVOC Content Limits outlined in the table below. This includes exterior-grade and solvent based paints should they happen to be used in interior application. Values should reflect the final product as mixed and ready to use, inclusive of tints. Exterior applications and internal car parks are excluded from these requirements.

The calculation for paints is to be based on the whole paint by grams of VOC per litre. The values should reflect the final product as mixed and ready to use inclusive of all additives, tints or the like.

Where the TVOC content of individual components is unknown it is to be determined experimentally using one of the following methods:

- ISO Method 17895 (2005) for a material with presumed VOC content <1%;
- ISO Method 11890 (2006) for a material with presumed VOC content <15%;
- ISO Method 11890-1 (2007) for a material with presumed VOC content >15%; Or
- ASTM D3960.

Table 1: Maximum TVOC Content Limits for Paints, Varnishes and Protective Coatings

Product Type / Sub-Category	Max TVOC content (g/l of ready to use product)
Walls and ceiling – interior semi gloss	16
Walls and ceilings – interior low sheen	16
Walls and ceilings – interior flat washable	16
Ceilings – interior flat	14
Trim – gloss, semi gloss, satin, varnishes and wood stains (Application examples: Timber varnishes, timber paints, mild steel, galvanized metal, all metal types)	75
Timber and binding primers	30
Latex primer for galvanised iron and zincalume (Application examples: Mild steel, galvanised iron)	60
Interior latex undercoat	65
Interior sealer	65
One and two pack performance coatings for floors	140
Any solvent-based coatings whose purpose is not covered in table leq-13.1 in the GSSA Office V1 Technical Manual	200



14. REFRIGERANT / GASEOUS ODP

All HVAC and refrigeration equipment shall have refrigerants with Ozone Depletion Potential (ODP) of zero.

The contractor shall provide supporting documentation (e.g. manufacturer data sheets, receipts and suppliers' confirmation) detailing:

- Type of equipment;
- The quantity of equipment supplied to the project;
- The type/s of refrigerants used in the equipment and the quantity of refrigerant/s (in mass).

15. REFRIGERANT LEAKS

The Mechanical Services includes the provision of a refrigerant leak detection system. The refrigerant leak detection system is installed to cover high-risk parts of the plant. Mechanical systems utilizing refrigerants are required to be contained within a moderately air tight enclosure.

The Contractor is required to confirm that the Refrigerant Leak Detection system is installed in accordance with the design. The contractor is required to confirm the location, type and volume of all refrigerants installed on site.

The Operation Manual is to contain a description of the refrigerant leak detection system which outlines the function and operation of the system.

The As-built drawings are to indicate the location of all refrigerant types and indicate the moderately air-tight enclosure around each HVAC system containing refrigerants, with the location, size and intended operation of the sensors and openings identified.

16. ENVIRONMENTAL

The sub-contractor shall take the necessary care to avoid the release of Refrigerant gas into the atmosphere. In the instance of the gas having to be drained, the sub-contractor shall obtain the services of a gas-recovery company who specializes in the removal, storage and re-use of refrigerants.

Any refrigerant must have an ODP of zero.

Any paint/solvent based coatings, which are internally exposed in the building and applied on site, must have a VOC content of less than 200g/l.

17. INSULANT ODP

All thermal insulation for pipes and ducts shall have no ozone-depleting substances (zero-ODP) associated with either the manufacture or composition of the product. Fibre-based woven insulation products (e.g. glass fibre, mineral wool, polyester etc.) and foil insulation which are not manufactured by using blowing agents may be used.
It is the Contractor's responsibility to maintain and submit the following documentation:

- Summary of types and application of all thermal insulants installed on site with supporting confirmation from the supplier;
- Manufacturer's Data Sheets for all insulants installed on site. The MDS is to clearly confirm that the thermal insulants are free of ozone-depleting substances in both the manufacture and composition.

APPENDICES TO SPE-MM-0001

[redacted]

APPENDICES

A.	SCOPE OF THE WORK
B.	DIVISION OF WORK SCHEDULES
C.	DESCRIPTION OF THE SYSTEM, DESIGN CRITERIA AND DRAWING INDEX
E1	IN LINE TUBE FAN
E2	PROPELLER FAN
F1	AIR DISTRIBUTION SYSTEM
F3	REFRIGERANT PIPING
F4	ELECTRICAL SYSTEMS
G1	SPLIT TYPE AIR-CONDITIONING UNIT COMPLETE WITH REMOTE AIR-COOLED CONDENSER
H1	CONSTANT VOLUME SIDE WALL AIR TERMINAL
H2	CONSTANT VOLUME SQUARE/ROUND CEILING AIR TERMINAL
H3	EXTRACT RETURN TRANSFER AIR GRILLE
H4	DOOR GRILLE
H5	INTAKE/EXHAUST AIR WEATHER LOUVRE
G	VARIABLE SPEED DRIVE

[redacted]

APPENDIX A SCOPE OF THE WORK

1. GENERAL

The sub-contract works to be carried-out consists of the engineering, supply, erection, testing, commissioning into service, guarantee and maintenance of an air conditioning and ventilation installation as described herein.

The engineering and quality control equipment selection, shop drawings, testing, balancing, commissioning and preparation of operating, and maintenance manuals, and inspections are to be executed in a systematic manner, once programmed, under the Engineer's general supervision and direction. The preparation and submission for approval by the Engineer for:-

a) Equipment Selection
b) Shop Drawings
c) Testing, Balancing and Commissioning Documentation
d) Operating and Maintenance Manuals
e) Inspection Record Cards/Checklists

shall be in accordance with the project manager procedures defined by the Engineer.

The Sub-Contractor shall familiarize himself with these project management procedures and submit the detailed cost breakdown on his engineering and management as listed.

2. SPECIFICATION AND DRAWINGS

2.1 Engineer's Drawings and Specification

The drawings prepared by the Engineer show general layout of all equipment and distribution systems, complete with schematic arrangements. These, together with the specification, give sufficient information to enable the Sub-Contractor to estimate the cost and to determine how the system must be installed, tested, balanced, inspected, operated, serviced and maintained.

These drawings are not dimensioned installation drawings, and cannot be used as construction/shop drawings. Location dimensions shown are only indicative of the routes and zones in which the service must be installed.

2.2 Installation Drawings

2.2.1 Structural Drawings

The Sub-Contractor shall supply to the Engineer marked-up structural drawings or other drawings showing any changes or additional requirements to be made in the structure in order to fit apparatus and materials to be installed by him. However, it will be the Sub-Contractor's responsibility to ensure that sufficient installation clearance is provided for positioning the selected equipment into the building space provided.

2.2.2 Shop Drawings

Copies of shop drawings of all parts of the sub-contract works shall be submitted to the Engineer for approval. These drawings shall indicate all equipment, distribution systems, testing/inspection/instrumentation positions, access requirements and builder's work requirements.

Drawings shall be produced in Autodesk Revit 2015 or later format and the sub-contractor shall be able to receive and transmit drawings electronically.

Builder's work requirements shall include all work by others (holes in concrete, frames, masonry holes, bases, etc.) as well as the sizes, capacities and positions of service connections.

The Sub-Contractor may, if he so desires, purchase Revit electronic drawings of the Engineer's drawings for modification and updating if required. These drawings shall be re-titled in accordance with the Sub-Contractor's system and shall thereafter be submitted as the Sub-Contractor's shop drawings. No portion of the Sub-Contractor's work shall be commenced until the shop drawing has been approved by the Engineer.

"As Built" drawings on plastic foil shall be furnished on completion. These shall comprise the shop drawings as specified above, embodying all modifications made during construction, and further system diagrams indicating the intended functioning, capacity data and control functioning of all systems, as well as an electronic copy of the "As Built" Revit model. (The works shall not be certified as complete unless these drawings and the specified Operating and Maintenance Manuals have been submitted.)

2.3 Submission

Submission for approval will consist of the following activities executed by the Sub-Contractor and other parties involved:-

The Sub-Contractor shall review, stamp, date and sign to signify his approval and submit in the manner required by the Consulting Engineer and with reasonable promptness and in orderly sequence so as to cause no delay in the work, all contractor's drawings and samples required by the Sub-Contract documents or subsequently by the Architect. Contractor's drawings and samples shall be properly identified as specified or as the Architect may require.

At the time of submission the Sub-Contractor shall inform the Architect in writing of any deviation in the Contractor's drawings or samples from the requirements of the sub-contract documents.

The drawings shall be submitted in a number of copies and along the channels directed by the Architect for approval.

By submitting drawings and samples, the Sub-Contractor represents that he has determined and verified all site measurements, site instruction criteria, materials, catalogue numbers and similar data, or will do so, and that he has checked and co-ordinated with the other Contractor's drawings with the requirements of the works.

[redacted]

The Architect will review and approve construction drawings and samples with reasonable promptness so as to cause no delay, but only for conformance with the design concept of the sub-contract works and with the information given in the sub-contract documents. The Architect's approval of a separate item shall not indicate approval of an assembly in which the item functions.

The Sub-Contractor shall make any corrections required by the Architect and shall re-submit the required number of corrected copies of Contractor's drawings or new samples until approved. The Sub-Contractor shall direct specified attention in writing on re-submitted drawings to revisions other than the corrections required by the Architect on previous submissions.

No portion of the sub-contract works requiring a Contractor's drawing or sample submission shall be commenced until the submission has been approved by the Architect.

2.4 **Samples**

Samples are any samples required by the Architect or the Engineer. Samples shall be physical examples to illustrate materials, equipment or workmanship, and to establish standards by which the works may be judged. Such samples, after approval, will be retained by the Architect or Engineer for a period sufficient to ascertain that the relevant component is actually provided as per such sample, but will then be returned to the Sub-Contractor for incorporation in the works.

3. TESTING, BALANCING, COMMISSIONING, OPERATING OF PLANT AND BALANCING

Submit full testing, balancing and commissioning procedures for individual equipment and for the entire air conditioning and ventilation systems.

Include the following:-

a) Checking of all safety features of equipment by simulation of overload and abnormal conditions.

b) Setting of protective devices to stop operation of equipment at overload or abnormal conditions.

c) Checking of performance of equipment and systems by simulation through the range of maximum to minimum operating conditions.

d) Method of adjustments to correlate operating point with chosen point of application on the performance curves of equipment.

After physical completion has been reported and all defects made good, "start-up" shall take place and the above check-out procedures shall be carried-out.

Prior to the carrying-out of acceptance tests as defined in Clause 6 of Part IV, the Sub-Contractor shall operate the entire system for as long a period as may be required to provide satisfactory performance at all times in the occupied spaces served by that system for up to 24 hours a day continuously.

The Sub-Contractor shall provide all labour, supervision and equipment required for testing and operating the plant. "The Employer" may assign operating personnel as observers, but such observation time shall not be counted as instruction time.

The Sub-Contractor's operator(s) shall be fully conversant with the operation and experienced in running similar installations. The Sub-Contractor shall train the Employer's operator(s) to enable them to be responsible for and capable of operating the plant.

[redacted]

Logging of the plant operation shall commence once plant has been commissioned and the Sub-Contractor shall continue logging until the acceptance tests have been carried-out and the plant handed-over.

The Sub-Contractor shall also log, as part of his commissioning, outside air, supply air and room temperatures. These shall be recorded by continuous temperature recorders measuring the various temperatures simultaneously. Temperature recordings shall be taken over a minimum period of fourteen days at various positions designated by the Engineer.

All tests shall be recorded in a field test report for insertion in the operating and maintenance manual. Values of operating pressure, temperature and amps shall be marked on gauges and instruments as appropriate.

GREENSTAR TESTING, BALANCING AND COMMISSIONING

Comprehensive pre-commissioning, commissioning as well as quality monitoring shall be done on all the mechanical systems in a systematic manner and in exact accordance with CIBSE Commissioning Codes, as follows:

- CIBSE Code A – Air Distribution;
- CIBSE Code C – Automatic Controls;
- CIBSE Code M – Management;
- CIBSE Code R – Refrigerant Systems (Heat Pumps); and
- CIBSE Code W – Water Distribution

After completion of the contract, the contractor shall be required to provide training and system knowledge to the building owner/manager by submitting the following documentation:

- Design intent report;
- As-built drawings;
- Operational and Maintenance Manuals;
- Commissioning Records; and
- Commissioning Reports for each system;

The Commissioning Records must:

Demonstrate that the services were commissioned in compliance with CIBSE Commissioning Codes for all services;

Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues; and

Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations.

The Mechanical Subcontractor and Engineer will be required to provide as a minimum the following documentation:

- Definitive commissioning specifications;
- Requirements for witnessing including full details of tolerances applicable to all parameters;
- A commissioning program, including time for witnessing;
- Health and Safety risk assessment and method statements for the tasks to be completed;
- Commissioning method statements for each system;
- Pre-commissioning checklists for each system;
- Commissioning checklists; and.



- Commissioning certification for each system countersigned by the Engineer and accepting authority including the record sheets provided in each CIBSE code. .

The Operations and Maintenance Manual must describe how the facility will be operated and by whom, as well as the desired level of training and orientation required for the building occupants to understand and use the building systems.

Training:
In addition, the contractor shall provide training on all the systems to the building owners' building management staff. Full testing and commissioning procedures for individual equipment and for the entire systems shall be submitted.

Training provided must include:

- Information provided in the Design Intent Report (including energy/environmental features);
- Review of controls set up, programming, alarms and troubleshooting;
- Review of O&M manuals;
- Building Operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown);
- Measures that can be taken to optimize energy efficiency;
- Occupational Health and Safety (OH&S) issues;
- Maintenance requirements and sourcing replacements; and
- Obtaining and addressing occupant satisfaction feedback.

TOLERANCES

The indoor climate factors and air flow rates, heating, cooling and humidifying performances, electrical characteristics and other design data shall be measured at the ventilation system design air flow rate.

Tolerances of the measured values in respect of the selection of the measuring equipment are given in the following table:

PARAMETER	UNCERTAINTY*
Air flow rate, each individual room	± 10%
Air flow rate, each system	± 10%
Smoke extract	- 10%
Supply air temperature	22.5°C ± 1.5°C
Relative Humidity [RH]	50 ± 15% RH
Air velocity in occupied zone	0.5m/s ± 0,05 m/s
Air temperature in occupied zone	22.5°C ± 1,5°C
* The uncertainties include the permitted deviations from the design values as well as any measuring error.	

If the performance of the system requires closer uncertainties, this shall be specially defined in the documentation of the system. If product standards, national or local regulations require closer uncertainties, this shall be adhered to. Refer to control diagrams for additional tolerances.

4. COMPLETION OF SUB-CONTRACTOR WORK

Completion of the works will occur after the following procedure has been certified by the Architect as having been carried-out in accordance with the specification:-

a) Physical completion has been reported to the Architect by the Sub-Contractor, and all defects made good and the Architect has given approval for "start-up".

b) "Start-up" has taken place.

c) Commissioning and testing has taken place as specified and witnessed (where required), recorded and approved by the Architect.

d) One set of "as built" drawings, on computer discs have been furnished to the Architect, these shall comprise the "Shop Drawings" as specified in Clause 2.2.2 above, embodying all modifications made during construction, and further system diagrams indicating the intended functioning, capacity data and control functioning of all systems. For these latter drawings, the Sub-Contractor may, if he so desired, obtain plastic negatives of the Engineer's System diagrams for updating if required.

e) The specified five copies of indexed loose leaf manuals containing complete Operating and Maintenance Instructions have been furnished to the Engineer for all mechanical and electrical systems, equipment and controls, and for all other equipment or systems specified under this sub-contract. The Operating and Maintenance Manuals shall be set-out as described in Part IV.

[redacted]

APPENDIX B - DIVISION OF WORK SCHEDULES

The following related work to the air conditioning and ventilation (HVAC) sub-contract will be provided by others. The HVAC sub-contractor shall be responsible for the detailing, checking and ensuring that the work as listed in the schedules and shown in principle on the drawings is provided as per his detailed builder's work and related services drawings.

Instructions for the HVAC sub-contractor's exact requirements shall be transmitted to the Principal contractor and other sub-contractors timeously in the form of builder's and associated services drawings in accordance with an agreed programme. Should these instructions be issued after the completion of relevant areas, then this work will be carried-out at the expense of the HVAC sub-contractor.

- **Principal Contractor**

  Plant rooms

  Holes in core as per Structural and Architectural drawings.

  Unframed holes through wall (above ceiling) for every shaft to be bricked-up or sealed after ducting installation.

  Brick walls or fireproof partitioning around air conditioning plant rooms, and toilet ventilation shaft after completion of ducting installation.

  Concrete plinths.

  External weather louvers.

  Hoisting of equipment, such as ducting, piping, pumps, fans etc. **excluding chillers and air handling units.**

- **Plumbing Contractor**

  Condensate drain points in all plant rooms.

  Make-up water points for the chilled water system expansion tanks.

- **Electrical Contractor**

  The following related work to the air conditioning and ventilation contract will be provided by the electrical contractor:

  Power supply (3 Phase, Earth and Neutral) to the live side of the isolator of the distribution board on the roof.

  Fire interlock to potential free contact on relays in all the air conditioning distribution boards.

  Power supply and isolator (3 Phase, Earth and Neutral) with high temperature wiring to the basement ventilation fan high temperature control panels

  Power supply to and including isolators to the fan coil units on the floors will be provided fixed to the nearest cable basket

- **Fire Contractor**

  The following related work to the air conditioning and ventilation contract will be provided by the fire contractor:

[redacted]

Fire signal to be provided to each panel by the Fire Contractor to be terminated by the HVAC sub-contractor to be interlocked with all Air Handling Units and Fans (smoke/ stair case pressurization, etc).

[redacted]

APPENDIX C

DESCRIPTION OF THE SYSTEM, DESIGN CRITERIA AND DRAWING INDEX

Design Criteria and Comfort Levels

The following design criteria apply:

- **Outside Design Conditions**

  The design is based on CSIR report 300 "Climatic and Other Design Data for Evaluating Heating and Cooling requirements in Buildings".

Summer Outside	°C db	:	35
	°C wb	:	21
Winter outside	°C db	:	2

- **Internal Design Conditions**

Administrative Offices and Guardhouse

Summer dry bulb	:	22.5±1.5°C
Summer humidity RH	:	Uncontrolled but expected 30-60%
Winter dry bulb	:	21.0±1.5°C
Winter humidity RH	:	Uncontrolled but expected 20-50
Lighting load	:	17W/m2 average
Equipment load	:	15W/m2 or 350W/Equipment
People density	:	one person per 15m2 average
Noise levels	:	NC40
Minimum outside air	:	as per SANS 10400-O

Sodium Hypochlorite Generation Plant

Summer dry bulb	:	25.0±2.0°C
Summer humidity RH	:	Uncontrolled but expected 30-60%
Winter dry bulb	:	21.0±1.5°C
Winter humidity RH	:	Uncontrolled but expected 20-50
Lighting load	:	15W/m2 average
Equipment load	:	1500W
People density	:	one person per 15m2 average
Noise levels	:	NC40
Minimum outside air	:	as per SANS 10400-O

Chemical (Salt) Storage

Summer dry bulb	:	N/A
Summer humidity RH	:	Uncontrolled but expected 20-50
Winter dry bulb	:	N/A
Winter humidity RH	:	Uncontrolled but expected 20-50
Lighting load	:	N/A
Equipment load	:	N/A
People density	:	one person per 15m2 average
Noise levels	:	NC40
Minimum outside air	:	as per SANS 10400-O

- **Building Thermal Envelope**

Roof insulation – To a U-value of : 0.4 W/m²K

[redacted]

Façade Glazing : as per Architects drawings

- **Energy**

The buildings system is designed to meet SANS 204 energy requirements.

DESCRIPTION OF THE SYSTEM

- **Guardhouse Building**

The HVAC system in the guardhouse shall include one (1) Midwall Spilt Dx Unit, two (2) wall extract air system and one (1) fresh air system.

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	35 / 21
	Winter:	°C db / °C wb	2 / 0
Inside Design Conditions:	Summer:	°C	22.5 ± 1.5
	Winter:	°C	21.0 ± 1.5
	Humidity:	Uncontrolled	Uncontrolled
Office Noise Level:		NC	40
Lighting Loads:	SANS204	W/m²	17
Equipment Loads: (whichever is greater)	SANS 10400-part XA / Power input per equipment	(W/m²) / W	15 / 350
Space Population: (whichever is greater)	Number of seats or SANS 10400 - A.	No. or m²/persons	1 or 15
Minimum Outside Air quantity: (whichever is greater)	Or SANS 10400: Part O	l/s/person or ACH	7.5 / 2
Exhaust Air Rate - Kitchenette	Air changes per hour	ACH	10
Exhaust Air Rate - Wash closet	Air changes per hour	ACH	20

Fresh Air System

There is a single ducted fresh air system to be installed within the ceiling void, which will provide filtered air to the occupied space. The system comprises of the silent inline fan distributing air via galvanised spiral or round duct, flexible ducting, disc valves and diffusers. The fresh air shall also be supplied as make up air at back of house space to positively pressurise the area to ensure that airconditioned air does not to leak from the front desk to the toilet space.

Airconditioning systems

The midwall unit (evaporator) shall be installed inside the guardhouse. The condenser shall be placed on the outside of the building on the western side and connected to the evaporator through insulated refrigerant piping. On cooling mode,

[redacted]

the midwall unit (evaporator) shall absorb heat from the internal space and be rejected outside via the condenser coil. The cycle then reverses on heating mode. The Midwall Split Dx Unit will be remote controlled.

Extract Air System

Two (2) mechanical wall extract air fans shall be installed to extract foul air from both the kitchenette and the toilet space. A door grille shall be installed at the door of the toilet to allow make up air to flow to the negatively pressurised toilet space.

- **Administrative Building**

The HVAC system in the admin building shall be equipped with seven (7) Hideaway Spilt Dx Units, two (2) Midwall Split Dx Units, one (1) fresh air system, and one (1) toilet extract air system. All the associated condensers for the indoor units, the fresh air fan, and the toilet extract air fan will be placed on the northern and southern side of the roof slab of the building, alongside the solar panels as indicated on the drawing.

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	35 / 21
	Winter:	°C db / °C wb	2 / 0
Inside Design Conditions:	Summer:	°C	22.5 ± 1.5
	Winter:	°C	21.0 ± 1.5
	Humidity:	Uncontrolled	Uncontrolled
Office Noise Level:		NC	40
Lighting Loads:	SANS204	W/m²	17
Equipment Loads: (whichever is greater)	SANS 10400-part XA / Power input per equipment	(W/m²) / W	15 / 350
Space Population: (whichever is greater)	Number of seats or SANS 10400 - A.	No. or m²/persons	1 or 15
Minimum Outside Air quantity: (whichever is greater)	Or SANS 10400: Part O	l/s/person or ACH	7.5 / 2 (or 10)
Wash closets	Air changes per hour		20

Fresh Air System

There is a single ducted fresh air system, which will provide filtered outdoor air to the hideaway units which shall be installed within the ceiling void. The air distribution will be via galvanised rectangular main ducting and spiral ducting at the branches. Balancing dampers shall be installed in each branch to ensure the correct quantity of air is delivered to the unit. The flexible ducting will be used connect to the galvanised ducting to the units' plenum.

Airconditioning system

The hideaway units shall be installed within the ceiling void in all the meeting rooms,

offices, the control room, the canteen, and the sickbay. The return air shall be ducted system for each unit. The midwall units shall be installed above the doors of the battery and server rooms and will cool the air inside their respective rooms. The midwall unit shall be installed complete with stainless steel drip tray and condensate drain pump. On cooling mode, the midwall/hideaway unit (evaporator) shall absorb heat from the internal space and be rejected outside via the condenser coil. The cycle then reverses on heating mode.

Extract Air System

One (1) combined toilet extract air system shall be installed within the ceiling void and connected to the disk valves which will be installed within the male, female and disabled wash closets, and the male and female change rooms. The extract air ventilation will be via galvanised rectangular main ducting and spiral ducting at the branches.

- **Sodium Hypochlorite Generation (OSEC) Building**

- **Sodium Hypochlorite Generation Plant Area**

The HVAC system in the sodium hypochlorite generation plant area shall be equipped with three (3) Hideaway Spilt Dx Units and one (1) fresh air system. The installation of the HVAC system on the Sodium hypochlorite generation area of the building shall be exposed. The condensers of the hideaway units, along with the fresh air fan will be placed externally, on the roof slab on the southern side of the building.

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	35 / 21
	Winter:	°C db / °C wb	2 / 0
Inside Design Conditions:	Summer:	°C	25.0 ± 2
	Winter:	°C	25.0 ± 2
	Humidity:	Uncontrolled	Uncontrolled
Office Noise Level:		N/A	N/A
Lighting Loads:	SANS204	W/m²	15
Equipment Loads:		W	1500
Space Population:	Number of people	No.	5
Minimum Outside Air quantity: (whichever is greater)	Or SANS 10400: Part O	l/s/person or ACH	7.5 / 2

Fresh Air System

There is one (1) fresh air systems in the building. The fresh air system comprises of a cowl, a filter bank, an axial fan with sound attenuators, spiral ducting, and supply air grilles with opposed blade dampers. The air shall be supplied to the rear of the unit but will not be hard connected as it is not necessary.

Airconditioning system

The installation of the hideaway units shall be exposed at high level inside the generation plant. The units will not have a return air plenum because the air will be returned through the filter at the rear of the units. Supply air ducting shall be spiral and internally insulated. The supply air grilles shall have opposed blade dampers to control supply air flow. These grilles will supply air at 45° angle to ensure good air distribution.

- **Chemical (Salt) Storage**

System Description

Extract Air System

One (1) extract air system comprising of the corrosion resistant extract air fan (complete with VSD), PVC ducting and stainless-steel double deflection grilles which allow for 3550l/s of fowl air to be extracted shall be installed on the side of the wall to allow for cross flow of air. The air shall be extracted at high level. Fans to run 24/7.

Make-Up Air System

One (1) make-up air system comprising of the fresh air fan (complete with VSD), galvanised ducting, opposed blade dampers and stainless-steel double deflection grilles which allow 90% of the extract air to be replaced by fresh air and supplied at low level. Fans to run 24/7.

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	N/A
	Winter:	°C db / °C wb	N/A
	Humidity:	%	N/A
Inside Design Conditions:	Summer:	°C	N/A
	Winter:	°C	N/A
	Humidity:	%	N/A
Office Noise Level:		N/A	N/A
Lighting Loads:	SANS204	W/m²	N/A
Equipment Loads: (whichever is greater)	SANS 10400-part XA / Power input per equipment	(W/m²) / W	N/A
Space Population:	Number of people	No.	5
Minimum Extract Air quantity:	ASHRAE	l/s	3550

- **MCC Room and Fire Pump Room**

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	35 / 21
	Winter:	°C db / °C wb	2 / 0

[redacted]

Description		Unit	Value
Inside Design Conditions:	Summer:	Uncontrolled	Uncontrolled
	Winter:	Uncontrolled	Uncontrolled
	Humidity:	Uncontrolled	Uncontrolled
Office Noise Level:		NC	N/A
Lighting Loads:		W/m²	15
Equipment Loads:		N/A	N/A
Space Population:		N/A	N/A
Minimum Outside Air quantity:		N/A	N/A
Exhaust Air Rate - MCC	Air changes per hour	ACH	2

Systems Description

One (1) extract air fan for the MCC room and two (2) extract air fans for the Fire Pump room which allow for 2 air changes per hour of air to be extracted shall be installed at the perimeter of the wall. The fan shall be of wall-mounted type and shall be corrosion resistant.

- **Laboratory**
  The HVAC system shall be equipped with one (1) Midwall Spilt Dx Unit and one (1) separate fresh air systems.

Description		Unit	Value
Outside Design Conditions:	Summer:	°C db / °C wb	35 / 21
	Winter:	°C db / °C wb	2 / 0
Inside Design Conditions:	Summer:	°C	22.5 ± 1.5
	Winter:	°C	21.0 ± 1.5
	Humidity:	Uncontrolled	Uncontrolled
Office Noise Level:		NC	40
Lighting Loads:	SANS204	W/m²	17
Equipment Loads: (whichever is greater)	SANS 10400-part XA / Power input per equipment	(W/m²) / W	15 / 350
Space Population: (whichever is greater)	Number of seats or SANS 10400 - A.	No. or m²/persons	1 or 15
Minimum Outside Air quantity: (whichever is greater)	Or SANS 10400: Part O	l/s/person or ACH	7.5 / 2

Fresh Air System

There is a single ducted fresh air system to be installed within the ceiling void, which

[redacted]

will provide filtered air to the occupied space. The system comprises of the silent inline fan distributing air via galvanised spiral or round duct, flexible ducting, disc valve and diffuser.

Airconditioning system

The midwall unit shall be installed complete with stainless steel drip tray and condensate drain pump above the door. On cooling mode, the midwall/hideaway unit (evaporator) shall absorb heat from the internal space and be rejected outside via the condenser coil. The cycle then reverses on heating mode.

APPENDIX E1 – IN LINE TUBE FAN (SILENT TYPE / MIXED FLOW)

1. Supply and install as shown on drawings in line tube fans delivering the air quantities as listed in the schedule.

2. The fan pitch shall be manually adjustable.

3. The fan shall be a fully catalogued product and the documentation shall include sound power level spectrum, performance curves and/or tables for the expected range of operational conditions.

4. Performance curves and selection tables shall be based on a reproducible and certified test in an approved laboratory.

5. Submit at time of equipment submission:

   a) Detailed system resistance calculations for minimum/maximum pressure drops.

   b) Certified detailed selection shown on performance curves and/or tables for the specified conditions.

   c) Installation, operating, testing, balancing and commissioning instructions and trouble analysis guide.

   d) The estimated total expenditure on replacement of parts during the service life.

   e) The service and maintenance instructions.

   f) The possible percentage variation of data measured on site by the supplied and/or installed instrumentation compared to the published data.

6. Fan selection shall be in the stable part of the curve.

7. Fans shall be so constructed and installed that any sub-component replacement shall not take longer than 1 day when executed by qualified building maintenance staff.

8. The fan shall be engineered and components selected when operated under normal building conditions with optimum servicing and maintenance for a minimum acceptable service life of 15 years with 3 000 operating hours per annum.

9. The Engineer or his representative reserves the right to call for:-

   a) Test certificates and reports from the manufacturer's quality control laboratory or independent test laboratory such as SANS, and or

[redacted]

b) Site inspections, customer reports/references and user's interviews, and/or

c) Full engineering, design and component selection details to check the correctness of the claimed service life.

10. Fan installation shall comply with local authority by-laws and with Occupational Health & Safety Act of 1993, as amended.

11. Fan shall be factory assembled and shipped with all components - casing, motor, drive, vanes - factory mounted.

12. Fan assembly shall be installed in accordance with manufacturer's recommendations and shall be maintained in "as new" condition at start-up of installation.

13. Fan assembly shall be statically and dynamically balanced at the manufacturer's works within the design operating speed range.

14. Fan assembly shall be isolated from duct and structure by flexible connection and vibration isolation mountings with maximum vibration transmission as specified in Part IV.

15. Fan shall not be operated until connected ducts have been cleaned and specified filters have been put into regular operating condition.

16. Rotation arrow shall be installed.

17. Lubrication shall be possible while fans are in operation without removing any part and without danger of over lubrication.

18. An airtight inspection door sited to allow convenient access to the fan and motor shall be provided; alternatively fan casing may be arranged to pivot.

19. Fan casing shall not drum, distort or leak at any operating point and shall, if necessary, be externally sound insulated to maintain specified noise level in plantroom or adjacent rooms.

20. Motor rating shall not be less than the maximum power required by the fan at any operating point between zero and break-off capacity for the fan wheel furnished.

21. Motor shall be of the totally enclosed, squirrel cage induction, constant speed, continuous duty, variable torque type.

22. Fan shall be direct connected with motor inside the fan casing.

23. Fan assembly shall be suitable for vertical or horizontal mounting.

[redacted]

24. Power supply to motors shall be flexible.

25. Motor conduit box shall be mounted on exterior of fan casing. Lead wires from motor to conduit box shall be protected from the air stream.

SCHEDULE

Unit No.	DIAMETER (mm)	AIR Q.(l/s)	ESP (pa)	Ent. Air Temperature (^{0}C)	LOCATION
EAF01	160	50	150	28	OSEC
FAF01	160	50	250	35	OSEC
FAF01	250	130	350	35	GUARDHOUSE
EAF05	355	423	250	30	OSEC
EAF01	500	840	250	28	ADMIN
FAF01	500	320	400	35	ADMIN

[redacted]

APPENDIX E2 - PROPELLER FAN

1. Supply and install as shown on drawings the propeller fans handling the specified air quantities as listed in the schedule.

2. The fan shall be a fully catalogued product and the documentation shall include sound power level spectrums, performance curves and/or tables for the expected range of operational conditions.

3. Performance curves and selection tables shall be based on a reproducible and certified test in an approved laboratory.

4. The Sub-contractor shall submit at time of equipment submission-

   a) Detailed system resistance calculation for minimum/maximum pressure drops.

   b) Certified detailed selection shown on performance curves and/or tables for the specified conditions.

   c) The service and maintenance instructions.

   d) The estimated total expenditure on replacement of parts during the service life.

   e) Installation, testing, balancing and commissioning instructions and trouble analysis guide.

5. Fan selection shall be in the stable part of the curve.

6. The fan shall be engineered and components selected when operated under normal building conditions with optimum servicing and maintenance for a minimum service life of 10 years with 6 000 operating hours per annum.

7. The Engineer reserves the right to call for

   a) Test certificates and reports from the manufacturer's quality control laboratory or independent test laboratory such as SANS, and/or

   b) Site inspections, customer reports/references and user's interviews, and/or

   c) Full engineering, design and component selection details

   to check the correctness of the claimed service life.

8. Fan installation shall comply with local authority by-laws and with Occupational Health and Safety Act of 1993, as amended.

9. Fan shall be complete with wire guard(s) if accessible from either side.

10. Fan shall be installed in accordance with manufacturer's recommendations and shall be maintained in "as new" condition at start-up of installation.

11. Fan and motor shall be weatherproof and shall be protected from wind, rain and insects.

12. Fan shall be quiet in operation and shall be statically and dynamically balanced at the factory.

13. Bearings shall be of the permanently lubricated type.

14. Mounting plates shall not distort under any operating conditions.

15. Fan shall be mounted on vibration isolating mounting.

16. Power source to motors shall be through flexible conduit.

17. Fans shall be complete with an intake louver of suitable size to be mounted on the opposite side of the wall

SCHEDULE

Unit No.	DIAMETER (mm)	AIR Q.(l/s)	ESP (pa)	Ent. Air Temperature (^{0}C)	LOCATION
EAF02	400	500	-	28	OSEC
EAF03	400	500	-	28	OSEC
EAF04	400	350	-	28	OSEC
EAF01	150	40	-	28	GUARDHOUSE
EAF02	150	55	-	28	GUARDHOUSE

APPENDIX F3 REFRIGERANT PIPING

1. During the welding of refrigerant copper piping, a small amount of nitrogen must be passed through the pipes to avoid flaking of the inside of the piping.

2. Brazed joints shall be used instead of screwed or flared joints. The number of joints shall be minimized.

3. All refrigerant piping shall be well saddled and secured to minimize vibration of piping.

4. All pipes shall be de-burred and cleaned after being cut. Only circular pipe cutters shall be used, no sawing of pipes shall be allowed.

5. Pipe benders, flaring and swaging tools shall be used.

6. Sizing of refrigerant piping shall be done according to air-conditioning unit manufacturer's requirements, taking into account equivalent pipe length and height difference between evaporator and condenser.

7. Refrigerant piping shall be supplied by a reputable supplier and approved by the engineer

8. **All refrigerant piping must be pressure tested** at 20% above operating pressure, using nitrogen and the refrigerant that will be used in the system. The system pressure must be observed, and any reduction in pressure means that there is a leak in the system. An approved leak testing method must be used to find leaks. After leak repair, the pressure test must be repeated.

9. **All refrigerant piping system are to be evacuated with a vacuum pump,** to a pressure of 40 to 45 microns (electronic vacuum gauge). A two-stage vacuum pump must be used specially designed for this purpose.

   The manifold valves shall be closed off and vacuum observed for at least 2 hours. If there are no movement on the gauge, then there are no leaks or moisture in the system. Gauges will indicate between -80 and -100 kPa.

   If the vacuum reading moved above 45 microns in 2 hours, the system must be checked for leaks or further vacuum pumped to remove moisture.

10. **Records** of pressure testing and evacuation of each refrigerant piping systems must be kept and submitted to the mechanical engineer.

11. All thermal insulation used on the project shall have no ozone-depleting substances associated with either the manufacture or composition of the product. Fibre-based woven insulation products (e.g. glass fibre, mineral wool, polyester etc.) and foil insulation are not manufactured using blowing agents may be used. The supplier(s) of equipment shall confirm in writing that all insulants used are free of ozone depleting substances in both manufacture and composition. The supplier(s) shall identify the types and the properties of the insulants used and provide Manufacturers' Data Sheets confirming these. At practical completion, the contractor shall confirm that all insulants installed were as per the engineers' specification.



APPENDIX F4 - ELECTRICAL SYSTEMS

1. GENERAL REQUIREMENTS

The installation in its entirety shall be designed, engineered, installed and rendered serviceable in complete accordance with the following: -

a) South African Bureau of Standards, Code of Practice 10142-2006 for the Wiring of Premises.

b) All by-laws and ordinances of the relevant supply authorities.

c) Any particular requirements of this specification and drawings attached hereto.

d) The performance of the equipment offered shall be suitable for operation under the parameters detailed for :

   i. Site Connections

   ii. System Details

Any deviation from this specification shall be conditional upon the written approval of the Architect or his appointed representative.

The Sub-Contractor shall employ the services of an electrical specialist who shall be responsible for the application, engineering, documentation, supply, installation, commissioning and maintenance of the electrical system.

The installation in its entirety shall be in full conformity with the requirements of the local by-laws, supply authorities and with the requirements of all further authorities having jurisdiction.

Material and apparatus shall be in accordance with the relevant SANS or BS Standards. The former shall have precedence over the latter when both bodies have issued conflicting specifications or Coded of Practice.

The Sub-Contractor shall secure approval of all authorities as required for materials, equipment and installation.

The Architect or his representative reserves the right to call for test certificates and characteristic curves of every item of equipment to prove compliance with the standard to which it is built and to prove compliance with the specification regarding performance.

Test certificates shall be issued by a recognised testing authority and shall be submitted at the time called for.

Every care shall be taken to protect material, either fixed or unfixed, from damage.

All items shall be protected against the ingress of dust and moisture, so that no damage results to items and systems. All large items, requiring removal and exceeding 25 kg in weight, shall be fitted with lifting lugs or eyes.

All items of equipment mounted outdoors, equipment in air handling units and equipment mounted in a wet or possibly wet environment, shall be weatherproof.

Supply and installation shall include all equipment detailed on the approved shop drawings and wiring diagrams.

[redacted]

Commissioning shall include the validation of the systems as detailed on the shop drawings and wiring diagrams, and demonstrating that the electrical system does in fact provide the sequence of operation, control and safety operation as detailed on the approved wiring diagrams.

In addition, commissioning will involve the close co-operation of the electrical specialist contractor with the Sub-Contractor and operation and automatic control system contractor in adjusting the electrical system to provide the results intended.

The equipment, such as the starters, contactors, relays, etc., used in the electrical installation shall; be fully catalogued products and documentation shall include installation, testing, maintenance instructions and performance curves or selection tables for the expected range of operational conditions.

Methods of recording and presentation shall be suitable for incorporation in the Operating and Maintenance Manual, and for display in the plantrooms.

All items of the electrical installation shall be readily accessible for quick and easy replacement.

Adequate space shall be provided around all items for easy removal or parts.

2. CABLING

Particular care shall be taken with the selection and installation of cables to ensure that all parameters such as environment fault level, voltage drop and group de-rating factors are given full consideration.

Precaution shall be taken to prevent the ingress of water into cables.

Bending radii for cables shall be as large as possible. No radius shall in any event, during installation or when permanently installed, be less than the following: -

11 000 V grade	:	minimum	12 x Outside diameter
3 300 V grade	:	minimum	8 x Outside diameter
600/1 000 V grade	:	minimum	8 x Outside diameter
250 V grade	:	minimum	6 x Outside diameter

Where cables are clamped, cleated, strapped or bound to racks, the Sub-Contractor shall ensure that no sagging occurs, and that the pressure exerted by these fixing devices is not detrimental to the cable performance. Cables shall be clamped, cleated, strapped or bound to racks when in a vertical disposition at intervals not exceeding 0,5 metres whilst horizontally disposed cables shall be secured at intervals not exceeding 3 metres.

Care shall be exercised in the laying of the cables to prevent excessive crossing.

All cables shall be adequately supported during their installation to prevent undue internal stresses, particularly in the vertical configurations.

Each and every cable shall have permanently attached to it, at each end and at every 10 metres throughout its length, a label to exclusively identify the cable. The label shall be of the light gauge alloy, adhesive backed, "Dyna" type.

The characters embossed upon these labels shall be of a minimum of 3 mm high and shall correlate to the relevant cable number as depicted on the cable schedules.

2.1 **Terminations**

All terminations shall be carried out in a neat and orderly manner, particular care being taken to ensure that armourings form an effective earth path with all gland lock nuts, etc., being adequately tightened. Gland shrouds shall be fitted. All control cable cores shall be effectively identified by means of ferrules, the number correlating to the relevant inter-connection on the wiring diagram.

Where control connections are collectively marshalled in a common box, particular care shall be taken to ensure neat and orderly wiring looms with no undue crossing at the "crutch" points. Conductors shall be fitted with a "crimp type spade ferrule, before being inserted in the terminal box. The Sub-Contractor shall check that marshalling box identification labels correlate to the relevant diagrams.

Cable Testing

Upon completion of the installation of the cables, prior to actual termination, each and every cable shall be effectively tested for insulation breakdown and core continuity.

All cables shall be effectively tested for insulation breakdown with a 2 kV "Megger". Core and earth continuity tests shall be carried out.

Where control and power cables are terminated within equipment, every precaution shall be taken to ensure that the conductors are correctly terminated, to obviate cross connections of the power and control circuits.

All power connections to motors shall be checked, prior to dry running of machines, to ensure that the directional requirements of the equipment are correct.

All lugs fitted to cables shall be selected to ensure a good joint. Oversized holes and crimp tubes shall not be acceptable.

Lug barrels shall be sleeved where it is apparent that loose connections on motor/equipment studs could come into contact with each other or 'earth'.

The specialist Contractor shall ensure that all 'lock nuts' on equipment terminals are replaced and tightened.

Where it is apparent that vibration of equipment will occur, a loop of sufficient length shall be left between the static cable side and the equipment connection point.

3. **MOTORS**

Motors shall be liberally rated for the duty with due allowance made for temperature, altitude and possible variations in voltage. Motor ratings shall however, not exceed 120% of the required capacity.

Motor ratings shall not only be based on the full load requirements but motor capacity and starting characteristics shall be compatible with the requirements of the driven equipment. Motors shall be current catalogued products, preferably of South African Origin, and documentation shall include performance curves for expected range of operational conditions.

Motors shall comply with SABS 948, BS 2613 and/or BS 170 or other applicable standards of their country of manufacture.

Motors shall be protected against:-

a) Overloads - provide adjustable thermal overload protection in all three phase legs

[redacted]

capable of positive tripping at full load.

b) Single phasing - provide single phasing protection operative down to 45% of motor rating, independent of overload setting.

c) Short circuit - provide HRC fused switch or MCCB for starter back-up protection and motor short circuit protection.

d) Motors in excess of 200 kW rating shall embody a device which directly monitors the winding temperature for the class of insulation employed.

The power factor of motors, with capacities of 20 kW or more, shall not be less than 0,9 lagging under the operating conditions.

Motors shall normally be of the totally enclosed fan cooled type.

All motors of the air conditioning installation shall be of the same make or of the same interchangeable frame type. Variation in type and size shall be limited, wherever possible, to avoid duplication of spares.

In case of imported motors on equipment not kept in stock in South Africa, one spare motor for each 10 of the same type and size of motor shall be supplied to the building owner.

4. SWITCHGEAR

4.1 Definition

Fault level - The specified design fault level shall be deemed to be the symmetrical fault power available under short circuit conditions to the incoming terminals of the switchgear and subsequent interruptors, conductors, current transformers and the line side of the limiting device.

Fault duration - Shall be considered as the maximum period for which the equipment will be subject to the abovementioned fault condition. For the purpose of this specification, the period of fault duration shall be assumed to be equal to one second.

4.2 Design

Whilst all equipment shall be designed and manufactured in accordance with the aforementioned standards and accepted codes of practice, the following practices may be adopted providing that the vendor submits full details of his proposals.

Each section of centre fed busbars shall be rated at half the nominal requirements with loads distributed equally over each half of the bus-run.

Fuses of MCCB's shall be provided for the purpose of 'back-up' protection.

Where fuses are employed, starters up to 80 kW will be fitted with safety holders to BSS 88 whilst fuses in excess of 80 kW will be the bolted link type.

A control bus capable of being open circuited via an emergency stop operated relay shall be employed where an isolator is employed as an incoming device. This system shall be fail safe.

Where circuit breakers are employed, the 'Emergency Stop' shall cause a shunt trip mechanism to function.

[redacted]

5. SWITCHBOARDS

5.1 Construction Details

General - The switchboards shall be of a folded type cubicle construction to render a robust arrangement with a pleasant appearance.

Each cubicle shall be self contained and hold only the equipment for one circuit. Cubicles shall be capable of being isolated and the equipment therein being worked on without interfering with other equipment.

Particular attention shall be paid to the mounting of internal sub-assemblies with reference to their ability to withstand the dynamic stresses arising from the passage of fault currents at the anticipated levels.

Dust and vermin proofing - Where doors or removable covers are employed, dust proofing shall be achieved by means of gaskets of a suitable material and section.

This material shall be resistant to deterioration from the effects of heat, chemicals and moisture etc. it is preferred that these gaskets be of a minimum thickness of 10 mm compressible to half the original thickness.

The abovementioned gaskets shall be affixed by a suitable adhesive to the door or cover.

Suitable arrangements shall prevent the ingress of insects or vermin to any part of the switchgear.

Ventilation - Should the manufacturer's particular design necessitate ventilation to prevent the accumulation of ionised air, the manufacturer shall provide the necessary louvered openings.

Panel fixing and accessories - All door handles, catches and locks, etc., employed for the purpose of fastening doors or the fixing of removable covers shall be cadmium or chromium plated.

"Nelbar" type square key latching devices shall be utilised to secure doors or lift-off panels. Half turn knurled bolt arrangements will NOT be acceptable.

Where part of any device such as the abovementioned catches, pushbuttons or indication lights etc., pass through a door or panel, felt or neoprene washers shall prevent the contact of the devices with the panel paintwork.

Concealed hinge arrangements are preferred. However, plated projecting hinges are acceptable. All hinges shall be adjustable.

General Fixings - Under no circumstances will the use of self-tapping screws be acceptable other than for the purpose of affixing labels.

"Hank Nuts" washers and spring washers shall be suitably treated against oxidisation. Untreated mild steel bolts etc. will NOT be acceptable.

Lifting and loading facilities - The units shall be manufactured in such a manner that the maximum length of any section does not exceed 3 metres.

The manufacturer shall provide a lifting/loading diagram.

Each section shall be provided with ample lifting facilities so arranged that stresses,

[redacted]

incidental to shipping, create no distortion to any part of the section.

Painting and finishing - All metal work shall be eradicated of grease, rust and 'millscale' before the application of self-etching zinc chromate primer.

The primer shall be followed as soon as possible by two coats of the best quality air drying enamel paint to BSS 381C. Paint shall be to an approved colour. The interior finish shall be semi-matt white.

A suitable quantity of exterior and interior paint shall be supplied for the purpose of final touching-up on site after erection.

5.2 **Electrical Details**

Incoming/Outgoing connections - Adequate space shall be allocated by the manufacturer for the satisfactory entry and termination of all cables.

For cables entering from trenches or ducts, the manufacturer may assume that a depth of 500 mm has been allowed for the transposition of all cables.

Gland plates shall be 16 swg 'blank' sectioned type and the manufacturer shall supply chassis punches to cover all sizes of glands (No. 0-5). The punches shall be guaranteed to cut the requisite number of holes. Collector bars or suitable connection flange shall be employed where the cables are of non-flexible type or more than one cable is to be terminated. Where single core cables are brought through a gland plate, special care shall be taken with respect of "Eddy currents". The glandplates shall be magnetically split by means of a suitable non-ferrous material.

Power terminals shall be grouped in the lower section of each cubicle and shall be the bar and bolt type, with the exception of termination of under 16 mm sq., which shall be of the conductor clamping type.

Control wiring shall be done in multi-stranded wiring (min. 1,5mm) 1100 V PVC. Any wire shall be identified at both ends by means of a "Critchley" type ferrule and shall be correlated to the relevant schematic/wiring diagram. Colour of wire shall match the phase from which it originates.

Where several sets of control wires terminate in one area, the terminal block shall be numbered with the corresponding wire number.

All wiring shall be neatly done and finished; either with the aid of approved wiring channel or laced with best quality lacing material at suitable intervals.

Sufficient slack of wire shall be allowed at all outlet points to enable the use of clip-on ammeters, etc. and such slack wire shall be neatly disposed.

The wiring shall be so disposed at the hinged side of the door to ensure that opening and closing does not impose stress on the wiring.

All small power and control wiring to external circuits shall be wired to a numbered terminal strip with not more than two wires being fixed to any one terminal.

Terminal blocks shall be suitable for mounting on standard channels and shall include at least 12 spare terminals for future extensions.

Multiple ratio current transformers shall be wired to a terminal block accessible from the front of the switchboard. The terminal block shall have provision for selecting the ratio required and for short circuiting windings not required.

[redacted]

Where multi-core cables are brought into the board, they shall be properly finished-off at the entry point and the cores terminated at an enclosed terminal strip for connection to the board wiring.

Incoming Circuit Breakers - Where incoming supplies are controlled via a circuit breaker, these shall be of the air withdrawable pattern.

Shutters shall be provided on the fixed section to screen automatically any inadvertent contact with live contacts.

Closing mechanisms of the abovementioned circuit breakers shall be of the hand-charged spring release type.

Tripping shall be caused by all three of the following functions:

a) Local manual

b) O/C and E/F D M T units

c) 220 V A.C shunt trip

Incoming circuit breaker cubicles shall be fitted with a busbar connected, selective phase to phase and phase to neutral reading voltmeter along with a selective line and out of balance reading ammeter.

Paralleling of supplies onto a common busbar shall be prevented by the employment of suitable interlocks, i.e. the fitting of the aforementioned circuit breakers with Ronis type locks, interchangeable with the bus-section switch.

Bus-section switches shall be of the load break/fault make type isolator.

Isolators employed as incoming switching devices shall be of the load break/fault make type.

Busbars shall be contained in separate chambers and shall be effectively screened against accidental contact and the ingress of undesirable materials.

All busbars and associated connections shall be adequately rated with due regard to temperature rise, altitude, proximity effects, and fault capacity. Phase to phase, and phase to earth clearances shall be measured by the taut string method and shall be in excess of those stipulated in BSS 162 for this class of equipment.

It is preferred that the major axis for any busbar be in the vertical plane, support arrangements shall obviate the possibilities of contact under short circuit conditions.

All busbar joints and taps shall be so constructed as to restrict temperature increase to acceptable limits as detailed in BSS 159.

High-tension bolts shall be employed for all electrical connections

Where dissimilar materials are jointed, consideration shall be given to any electrolytic or chemical reactions.

Oxidization of joint surfaces shall be prevented by means of a suitable compound or tinning process.

Service feeder circuits, where required, shall be equipped with suitably rated MCB'S or C.F.S. units.

[redacted]

Outgoing power connections shall be achieved by means of rear connections studs.

The configuration of these circuits shall facilitate easy connections of the cables.

5.3 **Motor Starting Circuits**

All line components associated with motor starting circuits shall have a rating at least 10% higher than the maximum imposed loads and in addition shall be rated for:

a) Overcurrents anticipated during the operating time of its own overload tripping device.

b) Fault currents (left through) by the circuit back-up protection device with due regard to the clearance time.

In starters employing more than one stage the changeover from initial to subsequent stages shall be automatic. Contactors shall be interlocked to prevent starting in the incorrect stage.

All motor starting contactors shall be fitted with thermal overload tripping devices with single phasing or differential characteristics.

Protective tripping device shall be of the manual reset type and shall provide for protection under all conditions of motor operation. The overload tripping device shall be adjustable within a range of 75 to 125% of motor rating. Alternative protection by electronic means incorporated overload trips and single phase protection will be considered subject to approval.

Starters and contactors shall be current catalogued products and documentation shall include full performance data.

The following equipment or approved equal shall be used:

Sprecher and Schuh
Siemens
Telemecanique
Klockner Moeller
Allenwest
MTE
Cutler Hammer
Merlin and Gerin

Starters mounted separately shall be of the duct, damp, vermin proof and totally enclosed metal clad type.

Each starter or contactor shall be complete with 3 current transformers for the ammeters in the integrated control panel. The ammeter shall be sized for the motor rating which shall not exceed 75% of the scale and be less than 25% of the scale. The ammeter shall be suitable to withstand the starting current and any fault current. Unless otherwise indicated, motors of 20 kW or more shall have Star Delta rating.

Starter and contactors shall have auxiliary contacts for remote fault condition, and status indication and interlocking required for the sequence of operation as specified.

The starter or contactor shall be so constructed and installed that either a sub-component replacement or total removal and re-installation of the entire starter or contactor will not take longer than one hour by a skilled electrician.

[redacted]

Wherever technically possible, all starters or contactors or relays shall be of the same make or type and size to reduce the number of spares.

The Electrical Contractor shall supply one spare contactor and relay for each 5 items of the same type and size.

Earthing - A continuous copper earth bar shall run the whole length of any switchboards. The cross sectional area of this bar shall be sufficient to carry the anticipated asymmetrical fault currents for the specified time.

In any event the abovementioned earth bar shall not be less than 25 x 6 mm H.D.C. Adequate arrangements shall facilitate the connection of a fourth core of any motor cable to this earth bar.

Suitable section brass studs and lugs shall be supplied at both ends of the switchboard for incorporation into the earthing system.

6. STANDARDS

The following equipment shall comply with the relevant South African Bureau of Standards (where available) and/or the British equivalent:

		SABS	BSS
Switchgear in general	:	-	162
Circuit Breakers	:	156	4752
Isolators	:	152	5419
Busbars	:	784 & 1195	158 & 159
Fuses	:	172	88
Contactors	:	1092	5424
Motor Starters	:	-	587
Indicating Instruments	:	-	89
Current Transformers	:	-	3938

7. GENERAL

7.1 Labels

Main designation labels shall be fitted to the centre of each complete MCC or distribution board.

Each cell or compartment shall have its function or reference indicated by a label. A circuit breaker supplying power for secondary services shall be separately labelled, and all power circuits shall be labelled with their relevant references.

Control circuit breakers, indication lamps and pushbuttons and other similar control devices shall be labelled in accordance with their respective functions.

Labels shall be of the engraved white on black Traffolyte type, and shall be affixed by self-tapping screws or a suitable adhesive.

Character sizes for the various labels will be as follows :

Main Labels	:	25 mm
Cell, Circuit or Compartment labels	:	12 mm
All other labels	:	4 mm

[redacted]

7.2 **Plenum Lights**

Lights consisting of watertight bulkhead type fittings shall be provided in each section of the air handling plenum including the air washers.

The light shall be controlled by a switch on the outside of the plenum and on/off position indicated by a pilot light.

7.3 **Information and Drawings**

The specialist Contractor shall produce, in triplicate within two weeks of receipt of the contract, or in accordance with the agreed programme, the following data:

a) Final arrangement drawings
b) Fully detailed section drawings
c) Schematic and line diagrams
d) Descriptive literature and pamphlets of all electrical components employed in the manufacture of this switchgear
e) Test certificates
f) Comprehensive and schedule of spares

7.4 **Factory Inspection and Tests**

It shall be possible at any stage for a representative of the employer to inspect the work in progress.

On completion of the sub-contract, the following tests and inspections will be conducted by the manufacturer and witnessed by the employer's representative.

a) Compliance with the specification
b) A full series of primary injection tests
c) A full series of pressure tests on all wiring
d) Functional tests on all circuits and associated equipment

8. **ELECTRICITY SUPPLY SCHEDULE**

Supply voltage : 400V
Fault rating : TBC

[redacted]

APPENDIX G1 - SPLIT TYPE AIR-CONDITIONING UNIT COMPLETE WITH REMOTE AIR-COOLED CONDENSER

1. Supply, install and commission the inverter type air-conditioning units as shown on the drawings and with performance as listed in the schedule.

2. Controls and protective devices shall be factory wired and located in a readily accessible location. Control box shall be removable from front of unit.

3. The performance of the unit shall be fully documented and certified by a certifying authority in control of manufacture and/or ARI standard instrumentation ± 5% and/or SABS and CSIR for South African manufactured products. The documentation shall include:

   a) Sound power data for the octave band mid frequencies of 63 to 8000Hz, measured in enclosure and outside the enclosure as indicated on the arrangement drawing.

   b) The performance curves or tables stating Total and Sensible Cooling capacities with power absorbed, all at the altitude shown in the design conditions, for the following range of operating conditions:

      Entering Air Dry Bulb to evaporator 20 to 25 °C.
      Entering Air Wet Bulb to evaporator 14 to 19 °C.

   c) The possible percentage variations of data measured on site (with calibrated and certified instrumentation) compared to the catalogued performance data.

4. The unit shall be fully protected and shall be fail-safe. Minimum safety protection, caused by possible external abnormal conditions, shall be provided for the following and require manual reset after fault occurrence:

   a) High discharge pressure.
   b) Low suction pressure.
   c) Thermal overload for single phase motors.
   d) Combined thermal overload and phase-failure for three phase motors.
   e) Over/under voltage protection.

5. The unit capacity shall be controlled by a control switch and adjustable thermostat. Thermostat shall switch on the compressor automatically in accordance with the load. Appearance, finish and colour of exposed thermostats shall be to Architects approval. All controller set points shall be adjustable over a small range to enable fine-tuning to take place in the field.

6. Controllers shall be hard-wired and wall mounted if option is available. The HVAC sub-contractor shall co-ordinate his requirements and the positions of controllers with the main contractor and electrical sub-contractor.

7. Each unit shall be equipped with the necessary interface to enable it to be linked to a central controller which in turn shall be linked to a third party web based controller which will be used for scheduling, temperature and air flow rate set points and limitations, logging of historic trend data and group control of various areas and services, as specified under part V.D.7.01.03.

[redacted]

8. In addition to 3 above the Sub-contractor shall submit the following:-

   a) Installation and operating manual with check-out and start-up procedures;
   b) Normal and emergency operating instructions;
   c) Trouble analysis guide;
   d) Number and details of periodic services for recommended preventative maintenance programme;
   e) Warranty policy - Minimum requirement shall be one year for entire unit and 5 years for refrigeration equipment and accessories.

      NOTE: Warranty shall commence with the beneficial use of the equipment when set in operation.

9. The minimum selected service life for which the unit has been engineered and components selected when operated under normal building conditions with optimum servicing and maintenance, shall be 15 years with 5000 operating hours and 1000 stop and starts per annum.

10. The Engineer reserves the right to call for:

    a) Test certificates and reports from the Supplier's quality control laboratory and independent test laboratory such as SABS, and/or.

    b) Site inspections, customer reports, references and user's interviews, and/or.

    c) Full engineering, design and components selection details.

11. The units shall comply with regard to electrical safety and supply interference suppression requirements of SABS and/or local authorities by-laws. The units shall also comply with safety codes for mechanical refrigeration ASA-B9.I.

12. Special care shall be taken in crating, transport, delivery and instruction for storage on site to ensure that the units can be installed in "as new" condition.

13. The overall unit dimensions including mounting details shall not exceed those shown on the drawing. The Sub-contractor shall check the proposed enclosure and ducting details and ensure that all necessary provisions are made for the servicing and maintaining of the units in accordance with the supplier's service and maintenance instructions.

14. The unit shall be of the air-cooled, split type complete with inverter compressor(s), fan(s), filters, coils (remote condenser) electrics and safety controls.

15. The unit shall not drum, vibrate or leak under any operating conditions. Parts used in the construction of the units shall have adequate strength and the overall construction and installation shall ensure satisfactory operation under normal service conditions.

16. The air discharge of the air-conditioning units shall be as shown on the drawing.

17. Evaporator fan shall be of the direct-drive centrifugal type.

18. Units shall be furnished with washable filters, filtering the evaporator air. Mounting arrangements for filter shall obviate bypass of untreated air. Filters shall be easily removable from units.

[redacted]

19. Units shall be equipped with a hot dipped galvanized drain pan of sufficient size to trap condensate.

20. All electrical components of the unit shall be suitable for power supply of 380/220V with a variation of +- 10% without any modification to the basic unit.

21. The Sub-contractor shall submit, based on the unit manufacturer's noise criteria curves, certified sound insulation calculations from a noise expert for the enclosure including detailed construction and acoustic insulation drawings. The noise expert shall guarantee a noise level not exceeding the design values listed in Part VC for the enclosure for the specified maximum operating conditions.

22. Refrigerant shall be R410a, shall be non-toxic, non-flammable and odourless, with a zero ozone depletion potential and low global warming potential. R-22 gas will not be accepted. In the event the contractor was to recommend the use of a different refrigerant, approval shall be obtained from the Mechanical Engineer.

23. All condenser coils shall be protected from possible damage by hail by hail-guards.

24. Units shall be capable of operating safely (at reduced capacity) without tripping at an ambient temperature of 40°C.

25. Units shall be reverse cycle to provide heating (heatpump). A defrost cycle shall automatically be activated.

26. Units shall be equipped with variable speed (Inverter) type compressors.

27. Fan motors shall be of the EC (Electronically Commutated) type.

28. Each indoor unit shall have the ability to be connected to an absence detection sensor which will switch the unit off after a period of time that no occupancy is sensed inside the space. The sensor shall be provided by the electrician.

29. The units shall be equipped with the following features:

    a) Rotation and Back up functions
    b) Temperature Range Restriction
    c) Operation lock
    d) Auto Changeover
    e) High performance Groove piping used in Heat Exchangers

PERFORMANCE SCHEDULE

Note: The unit schedule shown in the Drawings indicates actual design capacities, and therefore unit selections must be de-rated for the following, and selected to satisfy both sensible and total capacity:

- **Altitude = Sea Level**
- **Indoor conditions – See system description in detailed specifications**
- **Outdoor conditions = 40°C DB**
- **Piping length and height**

Refer to the Drawings for identification.

[redacted]

APPENDIX H1 - CONSTANT VOLUME SIDE WALL AIR TERMINAL

1. Supply and install air terminals delivering the air quantities as shown on the drawings.

2. Unless otherwise indicated, the air terminal shall be complete with air quantity adjustment device accessible from the terminal face.

3. The air terminals shall be a fully catalogued product and the documentation shall include performance curves or selection tables.

4. Submit certified detailed selection shown on these performance curves or tables.

5. Special care shall be taken in transport, delivery, storage on site and installation to ensure that the air terminals are installed and maintained in "as new" condition at start-up of the installation.

6. The air terminal grille shall be epoxy powder coated or anodised aluminium, to an approved colour.

7. The Sub-Contractor shall supply a portable air measuring device, specified and calibrated by the air terminal manufacturer, to check the air delivery of the air terminals. The air measuring device shall work in conjunction with a commercially available meter. The combined assembly shall permit the operator to use the device and meter from floor level without the need for a ladder for terminals up to 4m above floor level.

8. Grille shall be of single/double deflection construction as shown on the drawings.

[redacted]

APPENDIX H2 - CONSTANT VOLUME SQUARE OR ROUND CEILING AIR TERMINAL

1. Supply and install Rickard or approved equal air terminals delivering the air quantities as shown on the drawings.

2. Unless otherwise indicated, the air terminal shall be complete with air quantity adjustment device.

3. The air terminals shall be a fully catalogued product and the documentation shall include performance curves or selection tables.

4. Submit certified detailed selection shown on these performance curves or tables.

5. Special care shall be taken in transport, delivery, storage on site and installation to ensure that the air terminals are installed and maintained in "as new" condition at start-up of the installation.

6. The terminal shall be epoxy powder coated to an approved colour.

7. The Sub-contractor shall supply the portable air measuring device, specified and calibrated by the air terminal manufacturer to check the air delivery of the air terminals. The air measuring device shall work in conjunction with a commercially available meter. The combined assembly shall permit the operator to use the device and meter from floor level without the need for a ladder for terminals up to 4m above floor level.

APPENDIX H3 – EXTRACT / RETURN / TRANSFER AIR GRILLE

1. Supply and install air grilles extracting/transferring the air quantities as shown on the drawings.

2. Unless otherwise indicated, the grille shall be complete with an air quantity adjustment device.

3. The grille shall be a fully catalogued product and the documentation shall include selection tables.

4. Submit certified detailed selection shown on these tables.

5. Special care shall be taken in transport, delivery, storage on site and installation to ensure that the grilles are installed and maintained in "as new" condition at start-up of the installation.

6. The grille shall be epoxy powder coated to an approved colour.

[redacted]

APPENDIX H4 - DOOR GRILLE

1. Supply and install as indicated, door grilles transferring the air quantities stated as shown on the drawings.

2. The door grille shall be a fully catalogued product and the documentation shall include selection tables.

3. Submit certified detailed selection on these tables.

4. Special care shall be taken in transport, delivery and storage on site to ensure that the door grilles are installed and maintained in "as new" condition at start-up of the installation.

5. The door grille shall be of the "no sight core" type and shall be finished in an epoxy powder coating to an approved colour.

[redacted]

APPENDIX H5 - INTAKE/EXHAUST AIR WEATHER LOUVRE

1. Supply and install as shown on drawings, outside air/exhaust air louvres for the air quantity at the static pressures.

2. The outside air/exhaust air louvres shall be fully catalogued product and the documentation shall include performance curves or selection tables.

3. Certified detailed selection shown on these performance curves or tables shall be submitted.

4. Special care shall be taken in transport, delivery, storage on site and installation to ensure that the outside air/exhaust air louvres are in "as new" condition at start-up of the installation.

5. The outside air/exhaust air louvres shall be installed as shown in principle on the drawings.

6. The louvres shall be finished in baked enamel to an approved colour or epoxy powder coated.

7. All outside air/exhaust air louvres shall be complete with mounting frames suitable to be built into the brick walls by the builder. All outside air/exhaust air louvres shall be vermin proofed.

APPENDIX I – VARIABLE SPEED DRIVE

1. General

1.1 The VSD shall be suitable for controlling the speed of standard three phase 380V - 415V induction motors.

1.2 The VSD is required to operate continuously at full load rating of the driven motor with variations of ±10% of the supply voltage and ±2% of the supply frequency.

1.3 The VSD is required to operate continuously at full load in an ambient temperature of 380C.

1.4 The VSD is required to operate continuously at full load at the stated altitude for the project. Where a de-rating factor is required by the Manufacturer this is to be applied to the VSD and not to the driven motor.

1.5 The VSD is to be manufactured to quality standards according to ISO 9001.

1.6 Unless stated elsewhere to the contrary it is to be assumed that the VSD is to be installed and operated in a high-tech commercial building with multiple tenants with an assortment of computers and sensitive electronic, radio, television and telecommunication equipment. The VSD is therefore required to operate without interference to this equipment.

2. Quadratic Torque Loads

2.1 The VSD unit is to be designed and built specifically for centrifugal fan and pump operation.

2.2 Maximum advantage is to be obtained in terms of energy saving by using an output voltage to frequency ratio allowing only sufficient magnetisation energy at the required motor speed.

2.3 The fans and pumps are expected to operate for extended periods at 50% of rated speeds and a running torque requirement of 25% of the rated value. At this 50% speed reduction the power consumption is to reduce to 12,5% of the rated full load value

3. Operating Parameters

3.1 Operating and set up parameters shall be selected and set by means of a programming keypad and associated display.

3.2 The VSD shall be suitable to respond to speed commands from 0 - 10Vdc and 0 - 20mA control signals and their respective inverted signals.

3.3 The VSD shall provide comprehensive information on the controller and motor condition. The following are minimum requirements:

3.3.1 Reference % of control signal.

3.3.2 Frequency Hz

[redacted]

3.3.3 Current A

3.3.4 Torque %

3.3.5 Power kW

3.3.6 Output voltage V

3.3.7 Motor RPM

3.4 The VSD shall be suitable for catching a rotating motor. Under certain conditions, the fan or pump may be rotating in its opposite direction and the VSD shall be capable of achieving a clean start under these conditions.

4. **Electrical Safety**

4.1 The VSD is to have all necessary WARNING or CAUTION notices permanently fixed to the VSD and VSD enclosure.

4.2 The VSD shall be suitable for service in mechanical plant rooms where dust, moisture and water is present. A minimum enclosure protection to IP54 rating is required. The VSD is to be mounted in a ventilated area allowing the dissipation of heat energy.

4.3 The VSD shall be suitable for switching on the output side. Motor reactors limiting the rise time of the current are a minimum requirement and are to be integral with the VSD.

4.4 Isolation of the mains supply to the VSD and from the VSD to motor is a requirement to allow for safe maintenance, repair and to prevent motor operation during set up procedures.

4.5 In the event that the VSD is mounted exposed to ambient condition the VSD shall have a minimum enclosure protection to IP54 rating and shall have a weather canopy mounted over VSD to protect it from direct sunlight and rain.

5. **Galvanic Isolation**

5.1 The VSD is to provide isolation between the control and power circuits to ensure dangerous voltages cannot be transmitted to control signals. This isolation shall be integral with the VSD and shall be capable of withstanding a test voltage of 2.5KV for 1 second.

[redacted]

6. **Main Disturbance**

6.1 The VSD is to be protected against transients on the main supply caused by short circuit faults, lightning strikes and the switching of power factor correction capacitors

7. **Mains Supply**

7.1 The VSD to incorporate all necessary chokes filters capacitors and motor coils to reduce and limit radio frequency interference and harmonics to a level which does not interfere with other equipment on the same power supply.

7.2 The VSD is to incorporate harmonic reactors in the d.c. link circuit as an integral part of the VSD.

8. **System Protection**

8.1 The VSD system is to provide protection from:

8.1.1 Over current and overvoltage

8.1.2 Under voltage

8.1.3 Overload

8.1.4 Over heating

And to include facilities for:

8.1.5 Current limiting setting

8.1.6 Auto restart following trip or power supply recovery

8.1.7 Soft stall function

8.1.8 Reactivation function following a momentary power interrupt

9. **VSD Overload Protection**

9.1 The VSD is to be protected on the power outlet against short circuits or earth faults on the motor terminals. The three phases of the supply to be continuously monitored and the system to shut down on a missing phase or thermal overload.

9.2 The VSD shall provide storage of all faults. Last fault memory in the event of power failure is required.

[redacted]

10. **Motor Overload Protection**

10.1 The VSD is to provide electronic thermal overload protection of the motor at all operating speeds. This protection is to allow for the cooling conditions experienced with the speed control. The VSD is to allow for a built in motor thermistor should the motor size be 22kW or more.

10.2 The VSD is to incorporate line reactors as necessary to achieve a power factor of the driven motor of not less than 0.9 at any given speed.

11. **Inverter Waveform**

11.1 The VSD is to have manufacturers installed protection devices on the outgoing supply to the motor to suppress the effects of the inverter wave form.

11.2 The VSD shall be of the type utilising digital PWM technology which will enable the full output voltage to be reached without waveform distortion. Derating of the specified motor KW is not permitted.

11.3 The VSD is to provide slip regulation by means of vector control of the output voltage and frequency to maintain a constant motor speed

12. **Radio Frequency/Interference/Radiated and Conducted Interference**

12.1 The VSD is to have manufacturers built in filters to suppress RFI, radiated and conducted interference.

12.2 The VSD shall comply with EMC/EMI standards for immunity IEC 802-805.

12.3 The VSD is to be contained in a metal enclosure to suppress radiated RFI. The earthing of this enclosure to be taken direct to earth.

13. **Motor Noise**

13.1 Electromagnetic noise generated by the VSD and motor is not to exceed a 10% increase over that of a standard motor on a commercial power supply when operating over the specified duty range.

13.2 The additional vibration generated by the motor when operated at reduced speed shall be attenuated by stiffness of base and selection of anti-vibration mountings. The resultant vibration transmitted to building structure must be no more than that of a standard motor on a commercial power supply.

[redacted]

14. **Computer Interface**

14.1 The VSD will normally be connected to a local standalone controller and with facilities to interface with a BMS system.

Interface facilities are required to allow operation and make data settings from a host computer. Monitoring of the speed controller status is to be provided giving.

14.1.1 Output frequency

14.1.2 Output current

14.1.3 Output voltage

14.1.4 Trip conditions

14.2 Where the BMS system is not currently in operation the system is to allow for future connection

15. **Commissioning**

15.1 The VSD is to be set up and commissioned by the manufacturer. A commissioning report showing all parameters and settings is to be included in the commissioning manual

[redacted]

SPECIFICATION: SPE-WW-0001

IRRIGATION SYSTEM

CONTENTS

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2.1 SUPPORTING DOCUMENTS 2
3. MEASUREMENT AND PAYMENT 3

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1. SCOPE AND PURPOSE

1.1 SCOPE

This Particular Specification covers the construction activities associated with the Muldersvlei reservoir embankment irrigation system.

This document is to be read in conjunction with the following specifications:

- SANS 1200 DB (1989) Earthworks (Pipe Trenches)
- Amendment to SANS 1200 DB
- SANS 1200 L (1983) Medium-Pressure Pipelines
- Amendment to SANS 1200 L
- SANS 1200 LB (1983) Bedding (Pipes)
- Amendment to SANS 1200 LB

1.2 PURPOSE

The construction of the irrigation system is to maintain the vegetation that serves as erosion protection on the dam embankment, as well as irrigation of plant/flower boxes that forms part of the aesthetics at the administration buildings respectively.

2. INTERPRETATION

2.1 SUPPORTING DOCUMENTS

The following datasheets, shall, inter alia, be applied together with this Specification:

a) Datasheet 1001757-2000-DST-WW-0001 Solenoid Valve 50 mm
b) Datasheet 1001757-2000-DST-WW-0002 Solenoid Valve 80 mm
c) Datasheet 1001757-2000-DST-WW-0003 Pop Up Sprinkler A
d) Datasheet 1001757-2000-DST-WW-0004 Pop Up Sprinkler B
e) Datasheet 1001757-2000-DST-WW-0005 Strip Pattern Nozzle
f) Datasheet 1001757-2000-DST-WW-0006 Valve Box
g) Datasheet 1001757-2000-DST-WW-0007 Irrigation Controller
h) Datasheet 1001757-2000-DST-WW-0008 Gate Valve
i) Datasheet 1001757-2000-DST-WW-0009 HDPE Pipe
j) Datasheet 1001757-2000-DST-WW-0010 Pop Up Sprinkler C
k) Datasheet 1001757-2000-DST-WW-0011 Adjustable Nozzle
l) Datasheet 1001757-2000-DST-WW-0012 Solenoid Valve 25 mm

The construction details are presented on the Project Drawings.

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3. MEASUREMENT AND PAYMENT

As specified in the payment Clause of bill C13 Landscaping and Irrigation.

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194C-BW-WP037

DATASHEET No. 1001757-2000-DTS-WW-0001: SOLENOID VALVE 50 mm

CLIENT N°. | PAGE 1/1

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0001: SOLENOID VALVE 50 mm	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**VALVE DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		ICV-201G, ICV-301 or Similar Approved	
2.03	Nominal Size DN	mm	DN50	
2.04	Valve Type		Diaphragm/Globe	
2.05	Rated Pressure	kPa	1000	
2.06	Rated Flow	l/s		
2.07	Connection Type (Threaded, Welded, Flanged)		Female BSP Threaded	
2.08	Face to Face distance	mm	(Specify)	
2.09	Actual inner bore	mm	(Specify)	
2.10	Loss coefficient K = (hm)/(v²/(2g))	K	(Specify)	
2.11	Pressure Regulation	Yes/No	Yes	
2.12	Pressure Regulation Range	bar	1 - 3	
3	**SOLENOID DETAILS**			
3.01	Manufacturer		Hunter, Rainbird or Similar Approved	
3.02	Model #		(Specify)	
3.03	Supply Voltage	V	24	
3.04	Supply Current (In-rush)	mA	370	
3.05	Supply Current (Holding)	mA	210	
3.06	Solenoid Function		Remote Valve Opening	
3.07	Submit Solenoid Data Sheet for Approval	Yes/No	Yes	
4	**CONSTRUCTION MATERIALS**			
4.01	Body material (CI, DI, CS, etc.)		PVC	
4.02	Diaphragm Material		(Specify)	
5	**GENERAL DETAILS**			
5.01	Total weight of valve (valve and actuator)	kg	(Specify)	
5.02	Main dimensions of valve (L x W x H)	mm	(Specify)	
5.03	Life expectancy (# open/close cycles)	No	(Specify)	
5.04	Percentage local production and content (valve and gearbox)	%	70	
6	**SUPPLEMENTARY DETAILS**			
6.01	Cost per unit	ZAR	(Specify)	
6.02	Pressure testing cost per unit	ZAR	N/A	
6.03	Cost per actuator	ZAR	N/A	
6.04	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ *Signature:* _____

[redacted]

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DATASHEET No. 1001757-2000-DTS-WW-0002: SOLENOID VALVE 80 mm

CLIENT Nº. | PAGE 1/1

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0002: SOLENOID VALVE 80 mm	L.vV	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**VALVE DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		ICV-201G, ICV-301 or Similar Approved	
2.03	Nominal Size DN	mm	DN80	
2.04	Valve Type		Diaphragm/Globe	
2.05	Rated Pressure	kPa	1000	
2.06	Rated Flow	l/s		
2.07	Connection Type (Threaded, Welded, Flanged)		Female BSP Threaded	
2.08	Face to Face distance	mm	(Specify)	
2.09	Actual inner bore	mm	(Specify)	
2.10	Loss coefficient K = (hm)/(v²/2g))	K	(Specify)	
2.11	Pressure Regulation	Yes/No	No	
2.12	Pressure Regulation Range	bar	N/A	
3	**SOLENOID DETAILS**			
3.01	Manufacturer		Hunter, Rainbird or Similar Approved	
3.02	Model #		(Specify)	
3.03	Supply Voltage	V	24	
3.04	Supply Current (In-rush)	mA	370	
3.05	Supply Current (Holding)	mA	210	
3.06	Solenoid Function		Remote Valve Opening	
3.07	Submit Solenoid Data Sheet for Approval	Yes/No	Yes	
4	**CONSTRUCTION MATERIALS**			
4.01	Body material (CI, DI, CS, etc.)		PVC	
4.02	Diaphragm Material		(Specify)	
5	**GENERAL DETAILS**			
5.01	Total weight of valve (valve and actuator)	kg	(Specify)	
5.02	Main dimensions of valve (L x W x H)	mm	(Specify)	
5.03	Life expectancy (# open/close cycles)	No	(Specify)	
5.04	Percentage local production and content (valve and gearbox)	%	70	
6	**SUPPLEMENTARY DETAILS**			
6.01	Cost per unit	ZAR	(Specify)	
6.02	Pressure testing cost per unit	ZAR	N/A	
6.03	Cost per actuator	ZAR	N/A	
6.04	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ ***Signature:*** _____

[redacted]

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REV. T0

DATASHEET No. 1001757-2000-DTS-WW-0003: POP UP SPRINKLER A

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0003: POP UP SPRINKLER A	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**SPRINKLER DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		I-25(NR 18 and 10) or Similar Approved	
2.03	Spray Radius Range	m	15 - 20	
2.04	Rated Pressure Range	kPa	300 - 620	
2.05	Rated Flow Range	l/s	0.6 - 1.2	
2.06	Connection Type		Threaded	
2.07	Precipitation rate	mm/hr	(Specify)	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.02	Overall Height	mm	(Specify)	
3.03	Pop-up Height	mm	(Specify)	
3.04	Exposed Diameter	mm	(Specify)	
3.05	Inlet Diameter	mm	(Specify)	
3.06	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ *Signature:* _____

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194C-BW-WP037

DATASHEET No. 1001757-2000-DTS-WW-0004: POP UP SPRINKLER B

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0004: POP UP SPRINKLER B	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**SPRINKLER DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		PGP-ADJ-05 or Similar Approved	
2.03	Spray Radius Range	m	6.5 - 8.5	
2.04	Rated Pressure Range	kPa	170 - 450	
2.05	Rated Flow Range	l/s	0.08 - 0.14	
2.06	Connection Type		Threaded	
2.07	Precipitation rate	mm/hr	(Specify)	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.02	Overall Height	mm	(Specify)	
3.03	Pop-up Height	mm	(Specify)	
3.04	Exposed Diameter	mm	(Specify)	
3.05	Inlet Diameter	mm	(Specify)	
3.06	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

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DATASHEET No. 1001757-2000-DTS-WW-0005: STRIP PATTERN NOZZLE

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E - FOR CONSTRUCTION
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G - AS BUILT
H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0005: STRIP PATTERN NOZZLE	L.vV	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water Quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**NOZZLE DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		SS-530 or Similar Approved	
2.03	Spray Pattern		Rectangular	
2.04	Spray Area	Width x Length (m)	1.5 x 9.1	
2.05	Rated Pressure Range	kPa	100 - 300	
2.06	Rated Flow Range	l/s	0.06 - 0.1	
2.07	Connection Type		Threaded	
2.08	Precipitation rate	mm/hr	(Specify)	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.02	Overall Height	mm	(Specify)	
3.03	Exposed Diameter	mm	(Specify)	
3.04	Inlet Diameter	mm	(Specify)	
3.05	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

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DATASHEET No. 1001757-2000-DTS-WW-0006: VALVE BOX

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0006: VALVE BOX	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**VALVE BOX DETAILS**			
1.01	Manufacturer		Hunter, Rainbird or Similar Approved	
1.02	Model #		VB-JMB or Similar Approved	
1.03	Box Shape		Rectangular	
1.04	Box Size	Length x Width (mm)	430 x 330	
2	**GENERAL DETAILS**			
2.01	Total weight	g	(Specify)	
2.02	Life expectancy	Years	(Specify)	
2.03	Construction Material		Plastic	
3	**SUPPLEMENTARY DETAILS**			
3.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

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DATASHEET No. 1001757-2000-DTS-WW-0007: IRRIGATION CONTROLLER

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0007: IRRIGATION CONTROLLER	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**CONTROLLER DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		X-Core or Similar Approved	
2.03	Transformer Input	VAC	230	
2.04	Sensor Inputs		1	
2.05	Output		24 V AC	
2.06	Ingress Protection		IP54 (Outdoor Controller)	
2.07	Number of Stations	No.	6	
2.08	Rain Sensor Plug-in	Yes/No	Yes	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.05	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost Per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

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DATASHEET No. 1001757-2000-DTS-WW-0008: GATE VALVE

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0008: GATE VALVE	L.vV	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**VALVE DETAILS**			
2.01	Manufacturer		AVK, Premier Valves, VOSA or similar approved	
2.02	Model #		(Specify)	
2.03	Country of Manufacture		South Africa	
2.04	Nominal Size DN	mm	DN100	
2.05	Gate Type (wedge, resilient seal, knife, etc.)		Resilient Seat	
2.06	Rated Pressure	kPa	1000	
2.07	Body Test pressure	kPa	1.5 x WP_{max}	
2.08	Seat Test pressure	kPa	1.1 x WP_{max}	
2.09	Flanges (BS, SABS, ANSI, etc.)		SANS 1123 T1000/3	
2.10	Raised Faced Flanges	(Yes/No)	Yes	
2.11	Flange Pattern (Long or Short)		Short	
2.12	Face to Face distance	mm	(Specify)	
2.13	Hand wheel operated	(Yes/No)	No	
2.14	Opening Method		T-Key	
2.15	Gearbox	(Yes/No)	No	
2.16	Rising-, non-rising spindle		Non Rising	
2.17	Welded-, bolted bonnet		(Specify)	
2.18	Actual inner bore	mm	(Specify)	
2.19	Loss coefficient $K = (hm)/(v^2/(2g))$	K	(Specify)	
3	**ACTUATOR DETAILS**			
3.01	Manufacturer		N/A	
3.02	Type of Actuation (manually, electrical, pneumatic)		Manual	
3.03	Electrical Operated:			
3.03.1	- Motor shaft output at site conditions	kW	N/A	
3.03.2	- Motor torque	N.m	N/A	
3.03.3	- Rotational speed	rpm	N/A	
3.03.4	- Full load current	A	N/A	
3.03.5	- Voltage	V	N/A	
3.03.6	- Enclosure rating (IP rating)	IP	N/A	
3.03.7	- Communication Module (Digital)		N/A	
3.04	Pneumatic Operated:			
3.04.1	- Mode of Operation (single-acting to spring, double acting)		N/A	
3.04.2	- Position indicator	(Yes/No)	N/A	
3.04.3	- Closing direction (left, right)		N/A	
3.04.4	- Operating pressure range (min... to .... max.)	bar	N/A	
3.04.5	- Nominal Operating Pressure	bar	N/A	
3.04.6	- Operating time at 4.5 bar pressure supply	s	N/A	
3.04.7	- Operating Medium		N/A	
3.04.8	- Torque at Rated Operating Pressure	N.m	N/A	
3.04.9	- Air Consumption at 6 bar per cycle 0°-90°-0°	l	N/A	

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DATASHEET No. 1001757-2000-DTS-WW-0008: GATE VALVE

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
4	**CONSTRUCTION MATERIALS**			
4.01	Body material (CI, DI, CS, etc.)		Ductile Iron or Cast Steel	
4.02	Bonnet/Stuffing Box material (CI, DI, CS, etc.)		Ductile Iron	
4.03	Gate material (CI, DI, CS, SS, EPDM Vulcanised, etc.)		Ductile Iron	
4.04	Body Seat Trim (Stainless Steel, Copper Alloy, Nitrile, etc.)		Stainless Steel	
4.05	Gate Seat Trim (Stainless Steel, Copper Alloy, EPDM Vulcanised, etc.)		Stainless Steel	
4.06	Spindle (Stainless Steel, etc.)		Stainless Steel	
4.07	Spindle Nut (Bronze, Gunmetal, etc.)		Bronze	
4.08	Scrapers (PTFE, etc.) - if applicable		N/A	
4.09	Gland Packing (Graphite, etc.)		(Specify)	
4.10	Handwheel (Mild Steel, CI, CS, etc.)		Ductile Iron or Cast Steel	
4.11	Type of interior lining (2-pack Epoxy, FBE, etc.)		FBE	
4.12	Type of exterior coating (2-pack Epoxy, FBE, etc.)		FBE	
5	**GENERAL DETAILS**			
5.01	Total weight of valve (valve and actuator)	kg	(Specify)	
5.02	Main dimensions of valve (L x W x H)	mm	(Specify)	
5.03	Life expectancy (# open/close cycles)	No	(Specify)	
5.04	Percentage local production and content (valve and gearbox)	%	70	
6	**SUPPLEMENTARY DETAILS**			
6.01	Cost per unit	ZAR		Price in BOQ
6.02	Pressure testing cost per unit	ZAR		Price in BOQ
6.03	Cost per actuator	ZAR		Price in BOQ
6.04	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ *Signature:* _____

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DATASHEET No. 1001757-2000-DTS-WW-0009: HDPE PIPE

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0009: HDPE PIPE	L.vV	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**PIPE DETAILS**			
2.01	Type of Pipe		SANS 4427	
2.02	Pipe Nominal Bore	mm	DN32, DN40, DN50, DN63, DN75, DN110	
2.03	Material Grade		PE100	
2.04	Pressure Rating		PN10	
2.05	Pipe Ends (Flanged, welded etc)		Compression Fittings	
3	**GENERAL DETAILS**			
3.01	Total length of pipe required	m	Refer to BOQ	
3.02	Pipe lengths	m	(Specify)	
3.03	Total weight of pipe per meter	kg/m	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per meter	ZAR	(Specify)	
4.02	Expected delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ *Signature:* _____

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DATASHEET No. 1001757-2000-DTS-WW-0010: POP UP SPRINKLER C

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0010: POP UP SPRINKLER C	L.vV	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**SPRINKLER DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar APProved	
2.02	Model #		PGP-ADJ-04 or Similar Approved	
2.03	Nozzle Type		Number 4 Red	
2.04	Spray Radius Range	m	9.4 - 10.4	
2.05	Rated Pressure Range	kPa	170 - 450	
2.06	Rated Flow Range	l/s	0.07 - 0.12	
2.07	Connection Type		Threaded	
2.08	Precipitation rate	mm/hr	(Specify)	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.02	Overall Height	mm	(Specify)	
3.03	Pop-up Height	mm	(Specify)	
3.04	Exposed Diameter	mm	(Specify)	
3.05	Inlet Diameter	mm	(Specify)	
3.06	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ *Signature:* _____

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DATASHEET No. 1001757-2000-DTS-WW-0011: ADJUSTABLE NOZZLE

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0011: ADJUSTABLE NOZZLE	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (Potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**NOZZLE DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		12 A Pro Adjustable	
2.03	Spray Pattern		Circular	
2.04	Spray Area	Radius (m)	3.2 - 4.1	
2.05	Rated Pressure Range	kPa	100 - 300	
2.06	Rated Flow Range	l/s	0.01 - 0.2	
2.07	Connection Type		Threaded	
2.08	Precipitation rate	mm/hr	(Specify)	
3	**GENERAL DETAILS**			
3.01	Total weight	g	(Specify)	
3.02	Overall Height	mm	(Specify)	
3.03	Exposed Diameter	mm	(Specify)	
3.04	Inlet Diameter	mm	(Specify)	
3.05	Life expectancy	Years	(Specify)	
4	**SUPPLEMENTARY DETAILS**			
4.01	Cost per unit	ZAR	(Specify)	
4.02	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

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DATASHEET No. 1001757-2000-DTS-WW-0012: SOLENOID VALVE 25 mm

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
T0	C	DATASHEET No. 1001757-2000-DTS-WW-0012: SOLENOID VALVE 25 mm	L.W	B.H	A.vdN	A.vdN	19/01/2023

	DESCRIPTION	UNIT	SPECIFIED	OFFERED
1	**MEDIUM DETAILS**			
1.01	Water quality (potable, raw, sewage, etc.)		Potable	
1.02	SG		1	
1.03	PH	pH	6.5 - 8	
1.04	Operating Temperature	°C	20	
2	**VALVE DETAILS**			
2.01	Manufacturer		Hunter, Rainbird or Similar Approved	
2.02	Model #		ICV-201G, ICV-301 or Similar Approved	
2.03	Nominal Size DN	mm	DN25	
2.04	Valve Type		Diaphragm/Globe	
2.05	Rated Pressure	kPa	1000	
2.06	Rated Flow	l/s		
2.07	Connection Type (Threaded, Welded, Flanged)		Female BSP Threaded	
2.08	Face to Face distance	mm	(Specify)	
2.09	Actual inner bore	mm	(Specify)	
2.10	Loss coefficient K = (hm)/(v²/(2g))	K	(Specify)	
2.11	Pressure Regulation	Yes/No	No	
2.12	Pressure Regulation Range	bar	N/A	
3	**SOLENOID DETAILS**			
3.01	Manufacturer		Hunter, Rainbird or Similar Approved	
3.02	Model #		(Specify)	
3.03	Supply Voltage	V	24	
3.04	Supply Current (In-rush)	mA	370	
3.05	Supply Current (Holding)	mA	210	
3.06	Solenoid Function		Remote Valve Opening	
3.07	Submit Solenoid Data Sheet for Approval	Yes/No	Yes	
4	**CONSTRUCTION MATERIALS**			
4.01	Body material (CI, DI, CS, etc.)		PVC	
4.02	Diaphragm Material		(Specify)	
5	**GENERAL DETAILS**			
5.01	Total weight of valve (valve and actuator)	kg	(Specify)	
5.02	Main dimensions of valve (L x W x H)	mm	(Specify)	
5.03	Life expectancy (# open/close cycles)	No	(Specify)	
5.04	Percentage local production and content (valve and gearbox)	%	70	
6	**SUPPLEMENTARY DETAILS**			
6.01	Cost per unit	ZAR	(Specify)	
6.02	Pressure testing cost per unit	ZAR	N/A	
6.03	Cost per actuator	ZAR	N/A	
6.04	Assembly delivery time	Weeks	(Specify)	

Regardless of any information provided in this technical data sheet, the equipment to be provided will comply with the specified requirements.

Name (Print): _____ ***Signature:*** _____

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SPECIFICATION: EL

SITE LABORATORY

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1 SCOPE

This specification covers the requirements for the provision of a Site Laboratory to conduct the acceptance control testing for the project. The laboratory shall be under the supervision of the Laboratory Manager, appointed by the Contractor, and will report directly to the Employer's Agent Representative or their designated representative.

2 DEFINITIONS

"Process Control" is the ongoing monitoring and control of the construction process itself in line with the specified requirements and contractor's internal procedures to ensure that all aspects of the construction process meet the required standards and specifications. The Contractor shall be responsible for all process control.

"Acceptance Control" is the evaluation of the finished product or completed work to determine whether it meets the specified standards and requirements. The Employer's Agent Representative in conjunction with the Site Laboratory shall be responsible for the acceptance control.

"Independent commercial laboratory" - This laboratory refers to a SANAS accredited testing laboratory facility in terms of their accredited test schedule and conformance with the ISO 17025 requirements. This laboratory is located away from site and conducts ordinary and special tests. The testing work is charged to whichever client places the order, at the applicable rates and tariffs.

"Site laboratory" refers to an independent site laboratory operating under the SANAS-accreditation of an independent commercial laboratory for the purpose of the Employer's Agent Representative Acceptance Control testing.

"Approved laboratory/Testing authority" shall mean any locally accredited laboratory that is located away from site and has been approved by the Employer's Agent for the testing of materials, products, elements and mixes used on site.

"Contractor's satellite laboratory" is a laboratory established by the Contractor on-site or at manufacturing plants for asphalt and concrete. The Contractor's satellite laboratory also carries out process control on materials stockpiles and bulk binder storage, as well as during the manufacture of asphalt and concrete mixes. All tests and procedures are undertaken in terms of a quality control plan.

"Ordinary Tests" refer to the range of tests that are routinely carried out as part of process and acceptance control as specified in the project specifications. The Site Laboratory shall be responsible for all ordinary testing.

"Special Tests" are tests deemed necessary by the Employer's Agent that go beyond the testing specified in the project specifications. These tests are not covered by this specification, and payment for special testing will be made through the provisional sums provided elsewhere in the contract.

3 GENERAL REQUIREMENTS

The Contractor shall erect, equip and staff the Site Laboratory to undertake the relevant acceptance control testing in accordance with the project specifications.

The laboratory shall be under the supervision of the Laboratory Manager and will report directly to the Employer's Agent or their designated representative.

The Site Laboratory shall operate under the umbrella of a SANAS-accredited main laboratory that shall be responsible for ensuring that all sampling and testing is carried out accurately and strictly in accordance with the relevant specifications. The main laboratory shall have a valid SANAS accreditation to operate a site

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laboratory.

The Contractor is responsible for determining the required capacity of the Site Laboratory to ensure that all testing can be conducted in accordance with the Scope of Works as well as the Contractor's programme. This includes determining the appropriate size of the laboratory, the number of personnel, and the amount of equipment needed based on the project schedule.

If the Contractor plans to use the Site Laboratory for process control testing, it is their responsibility to ensure that the laboratory provided under the contract has sufficient capacity to accommodate the additional testing requirements. The Contractor shall not be entitled to any claims for extensions of time or additional costs due to delays caused by insufficient testing capacity.

The Contractor shall submit a detailed proposal for the Site Laboratory to the Employer's Agent Representative for approval prior to commencing its establishment. This proposal shall include the facility layout, a list of equipment to be provided, and the CVs of the laboratory staff.

4 FACILITIES

The Site Laboratory shall be located within the project site premises in a position approved by the Employer's Agent Representative.

The laboratory shall be housed in a weatherproof, insulated structure with adequate lighting, ventilation, and temperature control. It should be resistant to dust, moisture, and extreme temperatures to ensure accurate test results.

The laboratory facilities shall be equipped with all necessary furniture and office equipment, including but not limited to desks, chairs, cabinets, shelving, as well as all required electronic equipment such as computers and printers.

Provision shall be made for a reliable and continuous power supply, including backup generators to ensure uninterrupted operations during power outages.

A reliable high-speed internet connection shall be provided for the laboratory to facilitate efficient communication and the timely issuance of test results to the Employer's Agent Representative.

The laboratory shall be provided with a consistent supply of clean, potable water.

Suitable waste disposal services shall be provided for the laboratory including both hazardous and non-hazardous waste, in compliance with local regulations, if required for the laboratory operations.

If required by the laboratory for sample drying, the contractor shall provide a gas supply.

All electrical, plumbing and gas installations shall have the necessary Certificate of Compliance.

5 LABORATORY EQUIPMENT

The Contractor shall equip the Site Laboratory with all necessary testing equipment required for the specified ordinary testing.

In cases where the complexity or frequency of a specific test does not justify the installation of certain equipment in the Site Laboratory, the testing shall be conducted at the SANAS-accredited main laboratory under which the Site Laboratory operates, or at another Independent commercial laboratory approved by the Employer's Agent Representative. In this case, the contractor's rates shall make provision for the cost associated with all ordinary testing to be done at the SANAS-accredited main laboratory under which the Site Laboratory operates, or at another Independent commercial laboratory approved by the Employer's Agent Representative.

Notwithstanding the above, the Site Laboratory shall, at a minimum, be equipped with all necessary tools and devices for conducting full soil, aggregate, and concrete testing. This includes, but is not limited to:

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- **Soil Testing Equipment:** Compaction equipment, moisture content devices, shear strength apparatus, consolidation apparatus, etc.
- **Concrete Testing Equipment:** Compression testing machines, slump test apparatus, curing tanks, moulds, etc.
- **Aggregate Testing Equipment:** Sieves, specific gravity apparatus, flakiness and elongation gauges, etc.
- **General Laboratory Equipment:** Balances, ovens, drying units, pH meters, and other standard laboratory tools.
- **Vehicles:** The Site Laboratory shall be provided with light delivery vehicles (LDVs) and drivers to facilitate all necessary sample collection and field-testing activities.

All equipment must be calibrated and maintained in accordance with relevant standards, and calibration certificates must be available for inspection by the Employer's Agent Representative.

6 PERSONNEL

The laboratory shall be staffed with qualified personnel with relevant experience in the testing of construction materials.

All laboratory personnel shall be trained and competent in the use of the provided equipment and in conducting the tests specified in the project documentation.

A detailed organizational chart of the laboratory staff, along with their qualifications and CV's, must be submitted to the Employer's Agent for approval.

The number of staff and their level of experience shall be appropriate to the Scope of the Works and the Contractor's programme.

Compensation for laboratory staff shall be per the requirements of the Contract.

Notwithstanding the above, the Site Laboratory staff shall at a minimum have the following staff for the full duration of the contract:

- A **Laboratory Manager** with a relevant higher certificate (NQF level 5) and at least 10 years' experience. The Laboratory Manager shall be responsible for managing the day-to-day operation of the Site Laboratory, be authorised to sign off the testing results, communicate with the Employer's Agent Representative, and be computer literate in the applicable software to perform the required duties.
- **A Senior Material Tester (Laboratory)** with grade 12 or an equivalent senior certificate (NQF level 4) and at least 10 years' experience. The Senior Material Tester (Laboratory) shall be responsible for the testing within the Site Laboratory and be competent and qualified to do all tests in all laboratory divisions (i.e., soils, concrete, aggregate etc.).
- **Senior Material Testers (Field)** with grade 12 or an equivalent senior certificate (NQF level 4) and at least 8 years' experience. The Senior Material Tester (Site) shall be responsible for all field-testing, be competent and qualified to do all field testing required, and have a valid driver's license.

In addition to the Site Laboratory staff, the SANAS-accredited main laboratory shall provide a competent and experienced **Quality Assurance Manager** assigned, who shall ensure compliance with the required quality standards. The Quality Assurance Manager shall be in the full-time employment of the SANAS-accredited main laboratory and shall visit the site as required to complete the duties required, but not less than twice each month (once each fortnight), which frequency may be increased on instruction from the Employer's Agent's Representative in the event of repeated and ongoing non-compliance by the site-based staff.

The Employer's Agent shall be entitled to instruct the Contractor to remove forthwith from the works any

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person employed for the Site Laboratory, in the opinion of the Employer's Agent, misconducts himself or is incompetent or negligent in the proper performance of his duties, or whose presence is otherwise considered by the Employer's Agent, on reasonable grounds, to be undesirable.

The duties of the Laboratory Manager and Quality Assurance Manager shall be as follows:

6.1 DUTIES OF THE LABORATORY MANAGER

Duty to manage the site lab facility and:

- Ensure the OHS requirements in the site laboratory are met.
- Ensure that the laboratory's environmental issues are taken care of.
- Ensure a tidy working environment.
- Co-ordinate the implementation of the quality system.

Duty to manage personnel and:

- Monitor the performance of the testing staff and coordinate HR development.
- Practical training and supervision of testers in accordance with laid down procedures.
- Maintain personnel and training files.

Duty to manage equipment and:

- Manage the maintenance – servicing and cleaning of equipment.
- Manage equipment and delegate operation of the equipment to testers.
- Ensure that the site laboratory has sufficient road-worthy and safe vehicles for sample collection and field testing.
- Calculate correction factors, display them and update them as and when required.

Duty to manage testing and:

- Act as leader of the site laboratory and provide direction to the activities of the laboratory.
- Liaise with the Senior Material Testers and Quality Assurance Manager for day-to-day running of the laboratory.
- Ensure that test methods are strictly followed.
- Ensure that all system problems are discussed with the QA manager and that the necessary steps are taken to adopt or implement further procedures to prevent recurrences.
- Monitor requests for testing and schedule sampling and testing activities.
- Ensure that the testing is conducted in good time.
- Stop testing activities (in consultation with the QA manager) and immediately inform the Employer's Agent's Representative.
- Ensure sample storage is managed and records are kept.

Duty to manage data and records and:

- Ensure that test data is captured, processed, backed up and retrievable.
- Issue worksheets to testers and coordinate correctness of samples to be tested.

Duty to issue test results within required time frames and:

- Co-ordinate reporting of test results and conduct final checking of test results by ensuring data transfer is correct.

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- Accept, sign and issue test results or reject test results and retest samples.
- Recall test reports erroneously issued to the Employer's Agent's Representative.

6.2 DUTIES OF THE QUALITY ASSURANCE MANAGER

Duty to implement the main laboratory's QA system on site and:

- Ensure that the quality system is implemented and followed at all times.
- Approve and issue worksheets, report sheets, verification sheets and test methods.
- Manages the administration and maintenance of all quality selected documents.
- Documents and make available new quality management processes and procedures or changes to them as appropriate.
- Immediately remove all invalid and obsolete documents.
- Ensure material testers' proof of competence is available on site.
- Ensure personnel and training files are kept up to date.
- Ensure the latest updated test methods are available to the testers.
- Ensure all computer software is validated and proof of validation is available on site.
- Ensure a correlation testing schedule is approved by the Employer's Agent's Representative.
- Ensure correlation testing is conducted in accordance with the approved schedule.
- Ensure that correlation test results are suitably recorded, reviewed and evaluated and the correlation results are available on-site in good time.
- Ensure regular and continued participation by the site laboratory in an accredited proficiency testing scheme.
- Ensure that equipment meets accuracy and specification requirements.
- Preparing calibration/verification schedules and maintaining schedules.
- Organise calibration of test and measurement equipment and check content of calibration certificates.
- Ensure the test results cannot be compromised by the site laboratory facility and testing environment.
- Ensure all critical supplies are procured from an approved suppliers list.
- Stop testing activities (in consultation with the lab manager) and immediately inform the Employer's Agent's Representative /Senior Materials Technician.
- Instruct resumption of testing.
- Ensure that test methods are strictly followed.
- Approve the format of standard reports to be issued on-site.

Duty to conduct audits in the site laboratory and:

- Ensure an internal main lab audit schedule is approved by the Employer's Agent's Representative.
- Ensure internal main lab audits are conducted in accordance with the approved schedule.
- Ensure that internal main lab audit reports are on site in good time.
- Ensure that they attend City of Cape Town or other external site laboratory inspections or audits.

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- Duty to raise and close out non-conformance in the site laboratory and:
- Ensure that non-conformance reports are raised in accordance with the main laboratory's QA system.
- Carry out root cause analysis on all non-conformances.
- Implement corrective action and preventive action timeously.
- Close out all non-conformances.

7 TESTING STANDARDS AND PROCEDURES

All sampling and testing of samples shall be carried out in accordance with the standard procedure prescribed by the following, in order of preference or as requested by the Employer's Agent Representative:

- Methods stated elsewhere in the project specifications.
- South African National Standards, Test Methods, codes and practice (abbreviation: SANS)
- "Standard Methods of Testing Road Construction Materials" published by the National Institute for Transport and Road Research as part of the series Technical Methods for Highways (abbreviation: TMH) and addendum. These include TMH 5 and 6.
- Technical Guidelines: The use of Modified Bituminous Binders in Road Construction (TG1- November 2007).
- Interim Guidelines: The design and use of foamed bitumen-treated materials (Asphalt Academy – TG2- May 2009).
- Standard test methods as described in Section 8100 of the Standard Specifications for the Road and Bridge Works for State Road Authorities (1998), issued by COLTO.
- SABITA Manuals.
- British Standards Institute Specifications (abbreviation: B.S.).
- American Society for Testing and Materials (abbreviation: ASTM).
- American Association of State Highway and Transportation Officials (abbreviation: AASHTO).
- European standards maintained by CEN (European Committee for Standardization) (abbreviated as EN)
- Other methods as supplied by the Employer's Agent Representative.

In all cases the latest amendment or revision current at the closing date of the tender is implied when reference is made to one of the above standards in the specification.

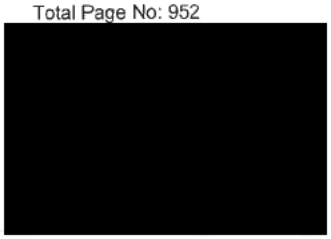
Prior to the establishment of the Site Laboratory, the Contractor shall provide to the Employer's Agent for approval a comprehensive list with all tests and sampling to be performed by the Site Laboratory and the applicable testing standard for each test. The main laboratory shall have a valid SANAS accreditation to perform laboratory testing in accordance with all applicable standards.

8 REPORTING

All reports and results shall also be submitted in a compatible electronic format to the requirement of the Employer's Agent's Representative. Original signed hard copies of results shall also be made available.

The Contractor shall be responsible, in consultation with the Employer's Agent Representative, for managing the reporting periods with the Laboratory Manager as required by the Contractor's Programme. The

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Contractor shall not be entitled to any claims for extensions of time or additional costs due to delays caused by the Site Laboratory.

9 QUALITY ASSURANCE

The Employer's Agent Representative reserves the right to inspect the Site Laboratory's equipment and compliance with the approved methods and specifications at any time, and to reject equipment not complying with the relevant specification.

The Employer's Agent Representative reserves the right to request an ad hoc SANAS technical assessment of the laboratory at any time during the contract.

10 HEALTH AND SAFETY

The Health and Safety specifications applicable to the Contract shall also apply to the Site Laboratory.

11 ENVIRONMENTAL MANAGEMENT

The Environmental specifications, including the Environmental Management Programme, applicable to the Contract shall also apply to the Site Laboratory.

12 MEASUREMENT AND PAYMENT

Rates and lump sums shall include full compensation for overheads, quality assurance in terms of ISO 17025, profits, incidentals, tax (other than VAT), etc, and for the complete items of work as specified in the specifications / scope of works for all the risks, obligations and responsibilities required.

12.1 FIXED CHARGES..... UNIT: SUM

The tendered rate shall cover all fixed charges for providing and establishing the Site Laboratory with all facilities, equipment, vehicles, personnel and other requirements. The tendered rate shall also cover the costs for the subsequent removal of Site Laboratory, and making good.

Payment of 80% of the tendered sum will be made upon the completion of the establishment of the Site Laboratory. The remaining 20% will be paid upon the removal of the facilities at the conclusion of the contract.

12.2 TIME-RELATED CHARGES ..... UNIT: SUM

The tendered rate shall cover all time-related charges for the operation of the Site Laboratory for the duration of the contract, including but not limited to personnel, consumables, equipment rental and maintenance costs, collecting and disposing of samples, etc.

Payment for this item shall be made in terms of Subclause 8.2.2 of SABS 1200 A.

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1 SCOPE

This specification covers the general requirements for open grid floors of glass fibre reinforced plastic (GRP), their supports and items ancillary to them. Open grid floors of steel are covered elsewhere.

2 INTERPRETATIONS

2.1 DEFINITIONS

In this Specification, the following shall have the meaning given:

"Grating" shall be synonymous with "grid flooring".

"Glass fibre" shall be synonymous with fibreglass"

"Covered open grid flooring" and "covered grating" shall be taken to mean open grid flooring with a permanently attached solid top GRP cover of the same material and finish as the grid flooring. Figure 2.1a illustrates covered open grid flooring (unbanded).

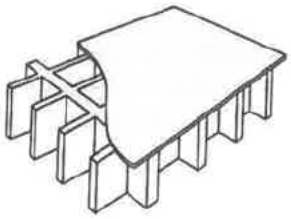


Figure 2.1a: An example of covered open grid flooring (unbanded), cover partially removed for illustration.

"Open grid flooring" shall include open grid flooring with an attached solid top cover of the same material (i.e. covered grating is also open grid flooring).

"Angle support" shall be synonymous with "frame" and refers to any cast-in or bolt-on type flooring panel support (whether of steel or GRP) with an L or Y profile, and which support may additionally include lugs, ribs or fasteners for anchoring. For GRP, this includes Fibergrate 'Ez Angle' (or similar) supports. For steel and GRP, this includes any support constructed from equal or unequal angle profiles.

"Additional support" shall mean any support, whether of steel or GRP, other than an angle support or top hat section (i.e., beams, channels, etc. are additional supports)

"Pitch" shall mean the centre-to-centre distance of bearer bars.

"Mini-mesh" shall be synonymous with "micro-mesh" and shall refer to a type of grid flooring panel which, additional the full-depth bearer bars, includes shallower bars at the top of the panel, midway between the full-depth bars. This halves the aperture size of the top half of the grid flooring (i.e. grid flooring with a 38x38 mesh pattern on the bottom and a 19x19mm mesh pattern on the top is a mini-mesh grid flooring). Figure 2.1b illustrates mini-mesh grid flooring (unbanded).

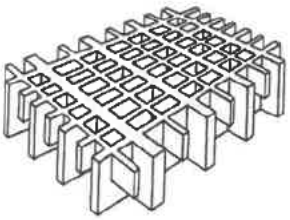


Figure 2.1b: An example of mini-mesh (unbanded)

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2.2 ABBREVIATIONS

The following abbreviations shall have the meaning given assigned to them:

GRP	:	Glass fibre reinforced plastic/polymer
HDG	:	Hot dip galvanised
UV	:	Ultraviolet
SS304	:	Stainless steel grade 304
SS316	:	Stainless steel grade 316

3 MATERIALS

3.1 GRATING AND SUPPORTS

Unless otherwise indicated, open grid flooring shall be of the moulded type (not the pultruded type) and supports shall be of the pultruded type. Both shall comprise of continuous glass fibre roving and a grey resin system (unless another colour is specified). The resin system shall consist of:

a) isophthalic polyester resin, unless otherwise indicated (vinyl ester resin is also acceptable),
b) UV inhibitors sufficient to enable the open grid flooring for use in outdoor application without showing any deleterious effects after ten years of external weathering in full sun exposure, and
c) flame retardants necessary to achieve a flame spread of 25 or less (ASTM E84 rating).

For the moulded grid flooring, the glass fibre content shall be 35% and the resin system content 65%, unless otherwise approved by the Engineer.

All GRP grating and supports shall be supplied with a certificate from the manufacture indicating that they comply with the above requirements.

Where additional supports of GRP are required, their end connections shall be of stainless steel grade 316, unless otherwise specified.

In some cases, steel supports may be indicated on the drawings, in which case they shall comply with the requirements of SANS 1200 H and shall be HDG unless they are of stainless steel or unless otherwise indicated.

Where top hat sections are shown on the drawings (i.e., for use with trench covers), they shall, unless otherwise indicated be of HDG mild steel and shall meet the requirements of SANS 1200 H.

3.2 FIXING CLIPS AND FASTENERS

All fasteners and fixing clip sets shall be of stainless steel grade 316, unless otherwise specified. Anchor fasteners shall be chemically anchored into concrete or brickwork using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved).

4 PLANT

Plant and equipment used in handling, fabrication and erection shall comply with the applicable regulations of the Occupational Health and Safety Act, 1983 (Act 85 of 1993). Handling and lifting plant shall have enough capacity to ensure that grating and supports are placed in their final position without distortion or undue stressing of members. The use of cranes, lifting devices, safety belts, harnesses, nets and barricades shall comply with the recommendations given in BS 5531.

5 CONSTRUCTION

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5.1 FABRICATION AND ASSEMBLY

5.1.1 General

Open grid flooring, supports and ancillaries shall be manufactured by an approved firm specializing in such work. The Contractor shall provide the Engineer with written confirmation from the suppliers indicating that the components comply with the requirements of this specification.

Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on site which may differ from those provided on drawings.

For all GRP items, any areas which are abraded, cut or drilled during or after the moulding or pultruding process (as applicable), shall be permanently sealed with a catalysed resin (with added UV inhibitors) compatible with the resin from which the item was manufactured. Alternatively, two coats of an aliphatic acrylic polyurethane topcoat suitable for use on GRP items in outdoor environments (such as Carboline 134 or similar approved) may be used as a sealant. The colour of the sealant shall either be clear or match the item being coated. Sealants shall be applied in accordance with the manufacturer's instructions in addition to the substrate being thoroughly cleaned and degreased, then wiped with acetone prior to applying the sealant.

5.1.2 Grating

Grid flooring shall be of the moulded type and bearer bars shall run in both directions (panels constructed of pultruded members or panels with bearer bars in one direction and transversals in the other are not acceptable). The grid flooring panel depth as well as the bearer bar thickness and pitch (spacing) shall be as specified on the drawings. The depth of bearer bars shall be equal to the panel depth.

Cut-outs made to accommodate equipment shall be neat and as small as practical. Gaps between equipment and grid flooring shall not exceeding 100mm in extreme cases. Unless otherwise specified, cuts made in grating with top covers shall create shapes to suit the equipment. For grating without top covers, cuts shall generally be parallel to bearer bars, except for cut-outs made to accommodate a circular object or pipe larger than 300 ND. In this instance, cut-outs shall be octagonal in shape to prevent excessive gaps and facilitate banding.

Where top covers are specified, they shall cover the entire top of the grid flooring panel with the edges of the cover flush with the edges of the flooring panel. The top cover shall be fully adhered to the grid flooring panel with a suitable epoxy adhesive approved by the grid flooring manufacturer and the Engineer, leaving no crevices at the joints. Mechanically fastening covers to panels is not acceptable.

Aside from grid flooring with solid top covers, the perimeter of any individual flooring panel, not limited to the outside perimeter, perimeter of cut-outs and perimeter of removable sections, shall be banded (with bands of equal thickness to the bearer bars) and without short bearer bar stubs protruding, to create a continuous perimeter surface of depth equal to the panel depth. If grid flooring is cut in such a way that edge bands are to be added, they shall be done so by fully and securely adhering bands (matching bearer bar dimensions) to the stubs with a suitable epoxy adhesive approved by the grid flooring manufacturer and the Engineer, leaving no crevices at the joints. Mechanically fastening bands to panels is not acceptable.

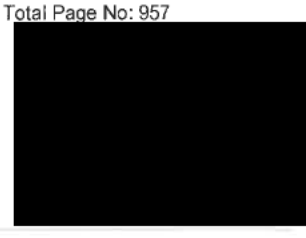
For mini-mesh grid flooring, the shallower bars included at the top of the panel will be acceptable as edge banding provided these bars have not been added, are of thickness equal to the bearer bars and have no bearer bar stubs protruding past them. However, if edge bands are to be added, they shall match the bearer bar dimensions (adding shallower bars is not acceptable).

Protrusions along the perimeter of grid flooring with solid top covers (where the full perimeter is not banded) and mini-mesh grid flooring (where edge banding is not full heigh) shall be neatly rounded to a radius of 2mm.

Edge bands added to grid flooring shall have the same top surface finish as the panel it is affixed to.

Where grid flooring is used as stair treads, their leading edges shall be fitted with a solid, gritted nosing of a colour approved by the Engineer. The nosing shall be fully adhered to the grid flooring panel with a suitable epoxy adhesive approved by the grid flooring manufacturer and the Engineer, leaving no crevices at the

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joints. Mechanically fastening nosing to panels is not acceptable.

5.1.3 Supports

Supports shall be as specified on the drawings and shall consist of angle supports and additional supports (see definitions in 2.1).

Where angle supports are specified, they shall be installed along the full perimeters of openings which are to be covered with flooring panels. In addition, where a structural member is to pass through a flooring panel, adequately sized bolt-on angle supports shall be installed around the circumference of the structural member to support the flooring panel, unless otherwise directed by the Engineer. No angle supports will be paid for separately but shall be included in the rate tendered for the relevant flooring panels.

Additional supports may be required and shall be as indicated on the drawings. Where an additional support consists of combining multiple structural profiles (i.e., two back-to-back channel sections with a flat plate or bar to create a single support), all members of the support shall be fully joined together using an epoxy or other suitable-for-purpose adhesive. The adhesive and joining method must be approved by both the GRP profile manufacturer and the Engineer.

Each additional support type, complete with end plates, flat plates/bars, fasteners, etc. will be scheduled and paid for separately to the flooring panels with angle supports.

5.1.4 Fixing clips and fasteners

Anchor fastener lengths and sizes shall be as shown on the drawings. Fasteners shall be delivered to site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on site).

Clip sets shall make use of fasteners no smaller than M8. The fixing clip sets shall be delivered to site already pickled and passivated and shall not be modified on site. Countersunk fasteners used to secure panels with solid top covers shall also be no smaller than M8.

5.2 SETTING OUT AND ERECTION

Actual dimensions and details measured on site may differ from those provided on drawings, and shall be accommodated.

Grid flooring shall be mounted firm and level, orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Adjacent floor panels shall have vertical edge alignment of within 2 mm of each other. Unless otherwise specified, no less than four fixing clip sets for panels smaller than 1.5m^2 and six fixing clip sets for larger panels shall be used to secure each panel to the supports and to adjacent panels. No perceptible movement or rocking will be acceptable.

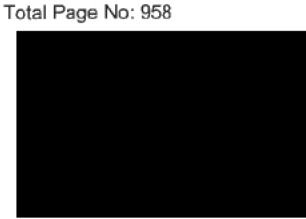
The gap between the edge of grid flooring and the support frame or abutting structure (as applicable) shall be at least 2 mm and no greater than 10 mm on each side (or no greater than 20mm on one side when the panel is shifted up against the support frame/abutting structure on the opposite side). No gaps shall be left between adjacent panels.

Unless otherwise approved, individual flooring panels which are not supported along their entire perimeter shall be no less than 1m wide (where the width is measured perpendicular to the shorter span). Where narrower widths are unavoidable, the narrower panel shall be fastened along the unsupported edges to the adjacent flooring panel with fixing clips at 250mm (or smaller) centres.

Where additional supports are installed, the gap between additional support ends and the substrates to which they are fixed shall be no greater than 10mm, and the gap shall be neatly filled with flowable non-shrink cementitious grout after the supports have been secured in place and prior to final tightening of nuts.

The Contractor shall submit for approval all relevant details for additional cut-outs and supports to flooring which are not specified but are required by him to accommodate his equipment. These flooring modifications

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and supports shall ensure that, while under design load conditions, the deflection does not exceed1/200th of the clear span, or 5 mm, whichever is the lesser. Cut-outs and supports required by the Contractor will not be measured or paid for separately but shall be included in the rate tendered for the relevant flooring panels.

Anchor holes required for supports shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive or fastener. SS316 washers shall be provided under both bolt head (where applicable) and nut. Unless otherwise approved, fastener threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed.

Countersunk fasteners shall be used with fixing clip sets to secure flooring panels which are covered with solid tops covers to supports and to adjacent panels. The countersunk fastener head shall not protrude above the flooring panel cover by more than 1.5mm.

In cases where the motor control centre (MCC) or variable frequency controllers (VFC) cover parts of the trench, supports and top hat sections shall continue under the MCC\VFC, however the GRP flooring panels shall not. Where flooring is supplied with top hats, 40x5mm neoprene strips shall be placed under all flooring edges not supported by a top hat section and adhered with contact adhesive to the angle support.

6 TOLERANCES

Grid flooring shall comply with the tolerances given in DIN 24537-3. GRP supports shall comply with the tolerances given in EN 13706-2. Steel supports shall comply with the tolerances given in SANS 1200 H. Adjacent floor panels shall have vertical edge alignment within 2 mm of each other.

Notwithstanding the above, supports shall be mounted or cast in (as applicable) such that the finished flooring panels, once installed, are flush with (or within 2mm of) the top of the abutting finished concrete or brick wall or floor (as applicable). The tolerance on spacing between parallel angle supports shall be ±3mm regardless of the substrate tolerance to which they are affixed or cast into. As such, the substrate tolerances shall be amended to ensure the angle support spacing tolerance is achieved.

7 TESTING

During installation, the Contractor shall satisfy the Engineer that, for all GRP items, any areas which have been abraded, cut or drilled during or after the moulding or pultruding process (as applicable), have been permanently sealed as specified.

The Contractor shall further demonstrate, after placing the panels but before securing them with clips, that when shifted to any side, the panels overlap the supports as specified.

After installation and once fixed in position, the Contractor shall demonstrate, to the satisfaction of the Engineer, that there is no perceptible movement or rocking of the flooring panels.

During the defects notification period, any fibre prominence on GRP items or delamination of top covers from the grid flooring panels will result in rejection of the applicable item.

8 MEASUREMENT AND PAYMENT

8.1 GRP FLOORING, COMPLETE AND INSTALLED WITH FRAMES (Drawing number and type stated)..... Unit: No, m^2 or sum

The rate shall cover the cost of supplying the specified or scheduled type of flooring complete with angle supports/frames and top hat sections as indicated on the drawings (irrespective of whether the angle supports/frames or top hat sections are of steel or GRP). The rate shall further cover the cost of all fixings, installing, fixing and grouting/casting in, the production of shop drawings/details (where required), all

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procurement costs, supply, fabrication, cutting, cut-outs, joining, banding, sealing, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the flooring and support frames.

Any additional supports and cut-outs not specified but which are required by the Contractor to accommodate his equipment layout shall not be paid for separately, but shall be included for in the above rate for flooring.

Additional support systems will be scheduled and paid for separately (under 8.2 if primarily of GRP and under Subclause 8.3.1 of SANS 1200 H if primarily of steel), which rate shall also include for the required end connections, flat bars/plates, fasteners, etc. Additional support systems exclude angle supports/frames and top hat sections, which are already included for under the rate for grid flooring.

8.2 ADDITIONAL SUPPORTS OF GRP (Drawing number and details stated).....Unit: No, sum or m

The rate shall cover the cost of supplying the specified or scheduled GRP additional support system, complete as indicated on the drawings, and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of shop drawings/details (where required), all procurement costs, fabrication, cutting, joining, sealing, transportation and erection, all plant, labour and materials (including end plates and fasteners) necessary for proper completion of the additional supports.

Any additional supports and cut-outs not specified but which are required by the Contractor to accommodate his equipment layout shall not be paid for separately, but shall be included for in the rate for grid flooring.

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BUILDING WORK

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1. SCOPE

This Particular Specification covers the various construction activities associated with the erection of buildings which form part of this Contract.

Building work shall be carried out in accordance with the National Building Regulations, SANS 10400, the applicable clauses of the SABS Standardised Specifications and the information contained in this Specification.

Work appurtenant to the erection of buildings such as earthworks, concrete work, structural steelwork, etc shall be carried out as specified in the appropriate Standardised Specifications and will be measured and paid for under those Specifications.

2. BRICKWORK, PLASTERWORK AND ROOF FINISHES

2.1 MATERIALS

2.1.1 Bricks

Burnt clay bricks shall comply with SABS 227 and shall be of the class and strength scheduled or shown on the Drawings. Unless otherwise specified, brickwork below ground shall be 14 MPa NFX solid engineering units in class I mortar (mortar with minimum 10 MPa compressive strength) and brickwork in superstructures shall be 7 MPa NFX solid engineering units in class II mortar (mortar with minimum 5 MPa compressive strength).

Face bricks shall, unless otherwise specified, be FBS solid engineering units in class II mortar. Face bricks shall be in the style and colour as specified on the drawings.

All load bearing bricks shall be at least 14 MPa bricks.

Concrete bricks, where specified or approved by the Engineer, shall comply with SANS 1215, and shall meet the same compressive strength and mortar class requirements as indicated above for burnt clay bricks.

Satisfactory proof of the load-bearing capacity of the bricks offered shall be submitted before deliveries are made to the Site.

Unless otherwise specified or approved, bricks shall measure 222mm long x 106mm wide x 73mm high (South African Imperial brick size).

Brick lintels shall be of the 'special solid' type that are solid on all sides (i.e. has no core holes).

Air bricks shall be well-burnt terracotta (or concrete for concrete brickwork) and shall be free from cracks and blemishes and lined with a durable, non-corrosive, non-degrading insect gauze.

Three samples of each type of brick shall be submitted to the Engineer for approval. All subsequent deliveries shall be of a standard equal to or better than that of the approved samples.

2.1.2 Cement

Cement shall comply with the requirements of SABS 471 and shall be stored under cover. The use of Portland blast-furnace cement (PBFC) which complies with the requirements of SABS 626 will only be allowed if approved by the Engineer.

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2.1.3 Aggregate

Fine aggregate shall consist of natural sand, or crushed rock or gravel, and shall be hard, clean and free from adherent coatings or other deleterious matter. Sand for plaster and mortar shall comply with the requirements of SABS 1090.

2.1.4 Water

Water shall be clean and free from clay, silt, oil, acid, alkali, organic or other matter which would impair the required strength and durability of the mortar, plaster or screed.

2.1.5 Wall ties and brickwork reinforcement

Wire ties shall be of galvanized steel of the single wire type for solid walls and either the "Butterfly" or Modified PWD type for hollow walls. Ties shall be of sufficient length to allow not less than 75 mm of each end to be built into brickwork or embedded in concrete. Vertical twist ties shall be used where specified on the drawings.

Brickwork reinforcement shall be manufactured from hard drawn steel wire conforming to BS 785 and shall consist of two 2,8 mm diameter main wires with 2,5 mm diameter cross wires at 300 mm centres welded at intersections.

Brickwork reinforcement shall be lapped not less than 300 mm at end joints and for a length equal to the width of the widest reinforcement at intersections.

2.1.6 Damp-proof sheeting

Damp-proof sheeting shall comply with SABS 248, type FV for fibre felt, or SABS 952, type B for embossed polyethylene sheeting.

2.1.7 Expansion/control joints

Expansion joints, masonry-to-concrete joints and the like shall be constructed as indicated on the drawings. Unless otherwise specified, the following shall apply:

a) All hoop-irons/straps/concertina ties shall consist of 750mm long by 30mm wide by 1.2mm thick galvanized steel strips.

b) For vertical masonry-to-concrete joints, each hoop-iron/strap shall be built 500mm deep into the brickwork after fixing one end to the concrete using 2x Fischer Hammerfix N6x40 anchors (or similar approved anchors, installed as per manufacturer's instructions). Each brick leaf abutting concrete shall have hoop-irons/straps built into the brickwork at approximately 255mm vertical centres (every third course).

c) For vertical masonry-to-masonry joints, each brick leaf shall have a concertina tie built into the brickwork at every fourth course.

d) All expansion/control joints shall be 10mm wide and consist of 10mm thick Jointex (or similar approved) compressible membrane, sealed (after being thoroughly cleaned) along the perimeter with a suitably approved polyurethane or polysulphide joint sealer of colour matching the wall finish. The sealant shall be applied against a full backing to ensure it is forced against the sides of the joint to obtain good adhesion, and the finished profile shall be no less than 12mm deep across the 10mm joint width, with the completed joint sealant face recessed 15mm for face brick or flush with brickwork/concrete to still receive plaster.

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2.2 CONSTRUCTION OF BRICKWORK

2.2.1 Cement mortar

Cement mortar shall, unless otherwise specified, consist of one part Portland cement to four parts sand (1:4) by volume for foundation brickwork and one part Portland cement to six parts sand (1:6) by volume for superstructure brickwork. The ingredients for cement mortar shall be measured in proper gauge boxes on a boarded platform and thoroughly mixed. Alternatively, mixing may be by means of an approved mechanical batch mixer. Only when the dry ingredients have been thoroughly mixed and a mixture of uniform colour has been obtained may the water be added in sufficient quantity to obtain mortar with the required consistency. The Engineer shall be present when the first batch of mortar is mixed and used.

Cement mortar shall be used within two hours of adding water to the mix and shall not be used after two hours or if it has begun to set. Mortar shall be turned over frequently to prevent it from setting until it is used.

2.2.2 Brickwork

Dimensions of all the brickwork shall be set out and built as shown on the Drawings and shall, unless otherwise indicated, not include plaster thickness. Wall thicknesses indicated in the BOQ and dimensioned on the drawings shall also, unless otherwise stated, exclude the thickness of the plaster (plaster not included for in the thickness given).

Bricks shall be kept wet before laying and the top of brickwork shall be wetted before any further bricks are laid. Bricks shall be well buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints to face brickwork shall be neatly made and key-drawn with a 6 mm key.

Face brick units shall be 'blended' by properly sorting and mixing the masonry units to ensure even distribution of colour, shape and texture across the entire finished wall. Clustering of variations will not be accepted.

Brickwork shall be carried up in a uniform manner with no portion being raised more than 1 m above an adjacent portion. Advanced work shall be raked back and toothing-in of masonry units shall not be permitted. All perpends, quoins, etc, shall be kept strictly true and square and the whole properly bonded together.

Brickwork shall be built in stretcher bond, unless otherwise specified, and bats shall not be used except where required for the bond. All joints shall be 10 mm wide and four courses shall measure 340 mm.

All brickwork shall be constructed with galvanized brickwork reinforcement build-in at every fourth course in superstructure brickwork and every second course in foundation brickwork.

Brickwork for cavity walls and solid walls built in stretcher bond shall be tied with wall ties at 255 mm vertical and 690 mm horizontal centres in foundations and at 340 mm vertical and 690 mm horizontal centres in superstructure brickwork, and shall be staggered vertically. At openings, the ties shall be positioned not more than 300 mm apart along the periphery of the opening and 150 mm from the opening.

Face brickwork shall be kept perfectly clean and rubbing down of the brickwork shall not be allowed. Scaffold boards shall be turned back during heavy rain to avoid splashing.

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Soiled brickwork shall be cleaned at the Contractor's expense, and the cleaning method shall be approved by the Engineer.

2.2.3 Reinforced brickwork

Unless otherwise shown on the drawings, brickwork over door and window openings shall be reinforced with steel rods, welded or expanded mesh, etc. Reinforcement shall be placed in each course of brickwork for a minimum of five (5) courses unless specified otherwise on the Drawings. Reinforced brickwork shall continue at least 600 mm on each side of the openings.

2.2.4 Lintels

Brick lintels (lintols) shall be built upon rigid temporary supports left in position for not less than seven (7) days after brick-laying. Brick lintels shall be of the 'special solid' type that are solid on all sides (has no core holes).

Pre-stressed concrete lintels be used where approved by the Engineer.

2.2.5 Key for plaster

Joints of all brickwork receiving plaster shall be raked out, or the brick surfaces shall otherwise be prepared with an acrylic slurry or any other approved bonding agent.

2.2.6 Damp-proofing

A damp-proof course/membrane shall be bedded in mortar (dry laying is not acceptable), laid over the full width of all the walls at a minimum height of 150 mm above the final ground level or wherever else it may be required, and it shall be lapped for at least 150 mm at angles and joints. A damp-proof course shall also be laid and stepped up under all external sills, and above all doors and windows that are not protected within 750mm above by a roof with overhang of at least 750m.

In some cases, torch-on waterproofing may, instead of damp proof course, be specified on the drawings. Torch-on shall comply with the "Torch-on Waterproofing" clause of this specification.

2.2.7 General

Rough and fair cutting shall be performed as required, and the brickwork shall be fitted around any steel work. Face brickwork shall be carefully cut and fitted to suit fittings.

Chases shall be left or formed for edges of concrete floors, staircases, etc. Chases shall also be provided wherever they may be required for pipes, conduits, switch boxes, distribution boards, and the like. Joints shall be raked out for flashings

2.2.8 Expansion/control joints

Unless otherwise specified, expansion joints shall be made, with prior approval of the Engineer, at all masonry-to-concrete interfaces. In addition, where vertical expansion/control joints shown on the drawings exceed 9m centres for 220mm or thicker collar-jointed walls, 7m centres for cavity walls, 4m centres for external 110mm single-leaf walls or 5.5m for internal 110mm single-leaf brick walls, additional joints shall be constructed (with the prior approval of the Engineer) such that the centre-to-centre distances do not exceed those indicated above.

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Expansion/control joints shall not be plastered over, with the plaster neatly finished on either side of the joint.

2.2.9 Face brick reference panel

Prior to commencing with face brick masonry work, a 1.2 m long by 1 m high by 280 mm thick (or similar approved) cavity reference panel (mock-up) shall be constructed in the presence of the Engineer using the proposed materials and tooling required for the final work.

The reference panel shall be constructed on a firm concrete base in a readily accessible area where it can be viewed in good natural light, and it shall be protected against moisture ingress. The panel shall match:

a) the proposed size, colour and texture of the masonry units,

b) the joint profile and the colour of the mortar,

c) the agreed bond pattern,

d) any special features.

The panel shall also incorporate:

e) the required reinforcing,

f) a damp proof course with weep hole,

g) a control joint (expansion joint) through the centre.

Face brick masonry work shall only commence after the panel has been accepted by the Engineer. The panel shall be the standard of workmanship to which the Contractor will be held, but shall not supersede the requirements indicated on drawings or specified.

The brick panel shall not be altered, damaged or moved until the masonry work is complete and has been accepted by the Engineer.

2.3 PLASTERWORK

2.3.1 General

Plasterwork shall meet the requirements of SANS 2001-EM1, unless otherwise indicated. Prior to commencing with plasterwork, the Contractor shall submit, for approval by the Engineer, a plasterwork method statement.

2.3.2 Substrate Preparation

In addition to preparing surfaces in accordance with SANS 2001-EM1:

- substrates shall be at least as rough as coarse sandpaper or rough-sawn timber,
- and masonry joints shall be raked to a depth of 10mm to provide a good mechanical key for plastering.

The Engineer shall be called to inspect all prepared surfaces prior to receiving plaster.

2.3.3 Plaster Coats

The Engineer shall be notified and witness the mixing and use of the first batch of mortar. A plastered finish shall consist of a single coat comprising one application of a 1:6 cement sand mixture with a wood or steel-float finish, except where otherwise indicated.

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Plaster shall be dampened by means of a light spray for a period of not less than 3 days after being applied to the substrate. Successive coats of plaster shall only be applied after the substrate coat has hardened sufficiently to bear a new layer or to enable a new layer to adhere to it and limit drying shrinkage crazing and cracking.

2.3.4 Thickness

The total thickness of the plaster finish shall be 13 mm minimum and 20 mm maximum, except where otherwise indicated. Plaster thickness is, unless otherwise stated, not incorporated in brick wall dimensions shown on the drawings or indicated in the BOQ.

2.3.5 Workmanship

All plasterwork shall be finished smooth and ready to receive paint. Plaster shall be flush with the faces of all switch and plug boxes, the interiors of which shall be kept free from plaster. Plastered surfaces shall be plumb and jambs and reveals shall be formed square.

Plaster shall be discontinuous across the line of a damp-proof course, a butt joint, a movement joint or at the interface between masonry and concrete elements. Unless otherwise indicated. the plaster at such interfaces shall be cut back to the substrate with a steel trowel to form a V-joint in accordance with SANS 2001-EM1.

The plasterer shall cut out and make good all cracks, blisters and other defects, ensuring that the plasterwork remains in a state which is acceptable to the Engineer. Delaminating plasterwork shall not be accepted.

2.4 ROOF FINISHES

2.4.1 Roof Screeds

This screed specification is only applicable to screeds applied to roofs, unless otherwise indicated. Granolithic screeds are specified in SANS 1200 G.

Where the type of screed required is not stated, the screed shall comply with:

a) this roof screed specification if applied to roof tops, or

b) the granolithic screed specification in SANS 1200 G if applied anywhere else.

2.4.1.1 Mix Design

Roof screeds shall have a mix proportion by mass consisting of one (1) part Portland cement and three (3) parts fine aggregate (1:3). A minimum amount of water is to be used, but it shall be sufficient to allow adequate compaction.

2.4.1.2 Preparation of base concrete

Preparation of base concrete shall be as specified for granolithic screeds/floor screeds in SANS 1200 G.

2.4.1.3 Placing

Placing shall be as specified for granolithic screeds/floor screeds in SANS 1200 G, but with the following two amended requirements:

a) The falls specified shall be increased to 1:80.

b) Instead of finishing the screed to Degree of Accuracy I, Degree of Accuracy II shall apply.

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2.4.1.4 Curing

Curing shall be as specified for granolithic screeds/floor screeds in SANS 1200 G.

2.4.1.5 Joints

Joints shall be as specified for granolithic screeds/floor screeds in SANS 1200 G, but with the following two amended requirements:

a) Additional joints are only to be made in the screed if, when matching the base concrete joints, the screed panel size will exceed 14m2. These additional joints shall be construction joints as defined for concrete in 1200G.

b) Additional joints shall be made such that joints are no more than 4.5m apart. These additional joints shall also be construction joints as defined for concrete in 1200G.

2.4.1.6 General

Screeds found to be delaminating shall not be accepted. No moisture-sensitive roof finishes or waterproofing shall be laid on screeds unless a reliable moisture test shows that the screed is sufficiently dry to receive the covering.

2.4.2 Crushed Stone on Roof Slabs

Where required, crushed stone shall be placed on roofs in thicknesses indicated on the Drawings (or 50mm where not indicated). The crushed stone shall be 19mm nominal stone complying with SANS 1083 grading criteria (including passing through a 25mm mesh sieve and retained on a 12mm mesh sieve). The crushed stone shall further be hard wearing and resistant to degradation and fouling.

The crushed stone shall be delivered to site clean and washed and shall not be placed without the permission of the Engineer and not until the concrete of the roof slab has reached the design strength. The Contractor shall, prior to placing, submit for approval a method statement indicating how the roof will be protected from damage during placing and spreading. During placing, the stone shall be immediately spread into position on the roof and no heaping-up of the stone will be allowed. Repairs to any damages caused by placing and spreading of the crushed stone shall be for the Contractor's cost.

If applicable, watertightness testing of roofs shall be done after the crushed stone has been placed and spread into position. The Contractor may, to satisfy themselves and at their own cost, conduct preliminary water tightness testing prior to crushed stone placement.

2.4.3 Torch-on Waterproofing

Unless otherwise indicated, torch-on waterproofing membranes shall be applied in accordance with manufactures instructions. A trial panel consisting of at least two overlapping membranes and covering what is considered by the Engineer as the most complex section of the roof or wall (as applicable) shall be prepared in advance by the Contractor for the Engineer's approval.

The Engineer shall be called to inspect all prepared surfaces prior to applying the waterproofing.

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3. DOORS, WINDOWS, LOUVRES, ETC.

3.1 MATERIALS

3.1.1 General

All steel and iron work shall be delivered clean and free from rust, pitting or other defects. Shop primers shall be applied before delivery and shall consist of a coat of red oxide paint, or any other approved anti-rust paint on all surfaces.

Unless otherwise specified, all materials shall conform at least to the appropriate SABS or BS standards where such standards apply to ironmongery, or steel, cast iron and any other related materials.

3.1.2 Pressed-steel door frames

Pressed-steel door frames shall comply with SABS 1129 and shall be manufactured from 1,6 mm thick mild-steel sheeting, pressed to the required shapes, properly mitred, welded and reinforced, with all welding neatly cleaned off.

Frames shall be of the widths required to suit the thickness of the walls into which they are built and shall be fitted with suitable tie bars and braces at the bottom. Three lugs to be built into the brickwork shall be provided on each jamb.

Rebates in frames and transoms for doors shall be of the widths required to suit the thicknesses of the doors and shall be fitted with a pair of approved steel butt hinges set flush into recesses in the frames. 4,5 mm thick reinforcing plates shall be welded to the backs of the frames at hinge positions.

Heads of frames over double doors shall be drilled where required to form keeps for bolts and shall be fitted with one rubber buffer for each leaf of the door.

Frames for single doors shall be fitted with approved chromium striking plates and an adjustable striking-plate keeper boxed in at the back of the frame by a welded-on sheet-metal box. The frames shall be fitted with a minimum of two rubber buffers.

Frames shall be protected against twisting and damage during transit and erection.

3.1.3 Pressed-steel doors

Pressed-steel doors shall be manufactured from 1,6 mm thick steel plate. The doors shall be of standard design, pressed to shape with 40 mm reveals all round. The doors shall be strengthened with full-length vertical V-shaped or other approved sectional strengthening ribs projecting to the outer face. Two horizontal stiffening rails shall also be welded to the inner face of the doors.

A door shall be hung on a pair of 100 mm long steel butt hinges with loose pins. The leaves of the hinges shall be welded to both the door and the door frame, and a 1,6 mm thick steel plate shall be welded to the inner face of the door to protect the lock.

One leaf of double doors shall be fitted at the top and bottom with approved 150 mm cast brass barrel bolts in an approved manner and the other leaf shall be fitted with a lock, the striking plate of which shall be fixed to the first leaf.

Where indicated on the drawings, doors shall be fitted with louvred ventilation grills of approved design, backed with insect and vermin-proof gauze screening.

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3.1.4 Wooden doors

External wooden doors shall, unless otherwise specified, be 44mm thick hardwood, face-boarded, framed, ledged and braced tongue-in-groove batten doors with 3mm tempered hardboard (high-density fibreboard) on the inside.

Internal wooden doors shall, unless otherwise specified, be 44mm semi-solid doors with 3mm tempered hardboard (high-density fibreboard) both sides and a core consisting of chipboard strips.

3.1.5 Steel window frames

All steel window frames shall comply with SABS 727 and shall be of the types and sizes shown on the Drawings.

Standard industrial types of steel window frame shall be constructed from rolled mild-steel industrial sections, 35 mm wide by 3 mm thick, with opening sections constructed from standard residential sections, 25 mm wide by 3 mm thick, welded at angles and properly jointed at intersections.

3.1.6 Aluminium doors, windows, louvres, etc.

The Contractor for the manufacturing and installations of the aluminium doors, windows, louvres, etc. is to submit proof of AAAMSA membership and doors, windows, louvres shall comply with AAAMSA design criteria.

The following certificates shall be provided prior to commencement of site work:

a) A copy of the relevant AAAMSA Performance Test Certificate from the manufacturer/contractor supplying the architectural aluminium product.

b) A Certificate of Conformance confirming that anodizing or powder coating has been processed in accordance with SANS 999 and SANS 1796 respectively.

c) A Certificate of Conformance confirming that glazing has been installed in accordance with SANS 10137, ensuring that safety glazing materials have been installed in the mandatory areas and that each individual pane of safety glazing materials has been permanently marked.

d) A warranty from the manufacturer of the laminated safety glass and/or hermetically sealed glazing units guaranteeing the products against delamination and colour degradation for a period of not less than five years.

The successful tenderer shall provide full shop drawings for the approval by the Engineer prior to the manufacturing of any work.

3.1.7 Roller Shutter doors

Roller shutters doors shall be suitable for external use in all weather including periodic extreme wind loading conditions. They shall include all components required for a fully operating door, including but not limited to the door curtain, channel guides, revolving spring-loaded shaft barrel with fully-enclosed canopy, lugs and fasteners, components for operating the doors and heavy-duty locks.

The curtain shall be manufactured from 1mm thick machine rolled galvanised interlocking solid slats with steel 'end locks' spot welded to alternate strips and 'wind locks' fitted at manufacturer approved intervals. The bottom slat shall be an aluminium T-bar (T-section) with integrated EPDM weather seal, unless the door is over 7m wide in which case a hot dip galvanised T-bar with manufacturer-approved weather seal will be accepted.

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The vertical edges of the curtain shall glide in hot-dip galvanised channel guides formed of steel not less than 2.5mm thick. The channel guides shall be mounted securely to sides of the door opening with SS316 fasteners, with fixing details and spacing approved by the manufacturer. The channel guides shall be no less than 76mm deep for doors below 6m in width and no less than 120mm deep for doors 6m and wider.

The door shall either be manually operated with crank and gearbox system or automated, whichever is specified. The canopy covering the opening mechanism shall be manufactured from 0.8mm (minimum) thick galvanised mild steel in a continuous length.

The door shall be finished with a UV resistant polyester powder coating if painting, powder coating or a finished colour is specified.

3.1.8 Door locks and handles

Unless otherwise specified, locks shall comply with the following requirements:

All door locks shall comply with the requirements of SABS 4 and shall be of approved manufacture and pattern. All locks shall be supplied with two keys. Keys shall be distinctly numbered with consecutive numbers and each key shall be stamped with the same number as that of the lock which it controls. No two locks in any one building may have the same key.

External doors shall be fitted with master-keyed four-lever heavy duty mortice locks or cylinder locks as indicated.

All locks shall be properly installed and, after completion, striker plates shall be adjusted and the locks serviced.

Door handles shall be of cast zinc of approved manufacture and pattern.

3.1.9 Miscellaneous fittings

All retaining devices for doors and windows as well as fittings such as coat hooks, retaining hooks, etc shall be of solid brass unless otherwise indicated. All fittings shall be secured by screws or set screws of the same material and finish as the fitting.

Fittings to be fixed to plastered walls, masonry or floors shall be fixed direct by means of patent plastic or fibre plugs fitted into drilled holes.

Door stops shall be provided at every external door and shall generally be 40 mm diameter rubber stops.

Patented precast concrete window surrounds or blocks shall be as scheduled in the bill of quantities.

3.2 INSTALLATION OF DOORS AND WINDOWS

All built-in door and window frames shall be set straight, plumb and level, and shall operate to the satisfaction of the Engineer after fixing has been completed.

Fittings shall be either removed, or wrapped and protected from damage, until all rough trades have been completed

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4. GLAZING

4.1 MATERIALS

4.1.1 Glass

Glass shall comply with the requirements of SANS 1263-1, unless otherwise specified otherwise. The quality of all window glass shall be such that surface deterioration will not develop after glazing.

All glass shall be free from bubbles, waviness, scratches, stains or other imperfections.

Unless otherwise specified, sheet glass for glazing shall be flat-drawn clear glass of ordinary glazing quality and of the thicknesses indicated below:

For panes not exceeding 1,5 m^2 in area: 4 mm

4.1.2 Putty

All putty shall comply with the requirements of SABS 680.

Putty shall not be too hard or soft or caked when used and shall dry evenly without crazing or cracking.

Defective putty shall be cut out and replaced by the Contractor at his own expense, and any broken glass shall also be so replaced and putty so repainted.

4.2 GLAZING

Glass shall be cut in panes to suit all glazed openings with sufficient clearance all round to prevent cracking by expansion, contraction or vibration.

In all cases the glass shall be well bedded and back-puttied and installed as specified in SABS Code of Practice 0137.

All putty shall be carefully trimmed, cleaned off and neatly finished off straight with smooth surfaces and sharp mitres. A paint primer shall be applied as soon as the putty has dried out sufficiently to prevent shrinkage cracks from forming.

The entire glazing operation shall be cleaned before the premises are handed over for occupation.

5. CARPENTRY AND JOINERY

5.1 GENERAL

5.1.1 Materials

All timber used for structural purposes shall be of merchantable grade and shall comply with the requirements of SABS 563 and SABS 1245. Structural timber shall be carefully selected and of the best quality, free from large or dead knots, shakes, waney edges or other defects. Purlins and brandering shall comply with the requirements of SABS 653. Finger-jointed structural timber shall comply with the requirements of SABS 096 and laminated timber with the requirements of SABS 1089.

Hardwoods and softwoods for joinery shall comply with SABS 1099 and SABS 1359 respectively and suitable species shall be used for the various purposes.

Unless otherwise specified, all materials shall conform to the appropriate SABS or BS Specification where such standards exist for nails, screws, bolts, adhesives, etc.

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5.1.2 Preservative treatment

All structural timber shall be given a preservative treatment suitable for the duty for which the timber is intended in accordance with SABS 05, and no untreated timber shall be used. The preservative treatment shall not impair the final finish. The timber shall be impregnated throughout. When surface coating is specified, the compounds applied on the surfaces of the timber shall form an unbroken film.

5.1.3 Priming

The jointing surfaces of all joints exposed to the weather and built-in portions of frames shall be thickly primed except where adhesives are specified.

Carpentry and joinery items which are prepared for painting by the manufacturer, shall be knotted and primed before being dispatched to the Site.

Primed surfaces shall be touched up where necessary during the progress of the work or where site adjustments have been made.

5.2 CARPENTRY WORK

5.2.1 Scope of work

Carpentry work shall be carried out in a manner consistent with good workmanship and in compliance with the Drawings.

The carpenter shall perform all cutting away and making good in attendance upon all other trades and he shall provide and maintain temporary coverings required for the protection of any finished work that might be damaged if left unprotected during the progress of the work.

5.2.2 Dimensions

Unwrought timber shall be as sawn and shall be to the dimensions and within the tolerances specified in the relevant SABS Standard Specifications mentioned in subclause 5.1 (1).

5.2.3 Jointing

Unless otherwise specified, all joints shall be secured by means of a suitable type and a sufficient number of approved connectors. All joints shall be carefully made in such a way that they will not impair the strength and stiffness of the beams or members.

5.2.4 Timber roof construction

The plates, joists, rafters, purlins, brandering and other pieces used for the construction of the roof and trusses shall be of the dimensions, spacing and construction as shown on the Drawings.

All the joints in the framework shall be of the most appropriate type, accurately formed and adequately secured with fasteners as specified.

5.3 JOINERY WORK

5.3.1 Scope of work

Joinery work shall consist of the manufacture, delivery to the Site, and fixing in the buildings, of all joinery shown on the Drawings.

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Except where a special finish is specified, the Contractor shall have all stairs, landings, doors, shelves and other joinery work cleaned and scrubbed down and shall leave all his work in a good order to the satisfaction of the Engineer.

5.3.2 Dimensions

All wrought timber shall be sawn, planed, drilled or otherwise machined or worked to the correct sizes and shapes shown on the Drawings.

Reasonable tolerances shall be provided at all connections between joinery works and the building structure to compensate adequately for any irregularities, settlements or any other movements.

5.3.3 Manufacture

The joiner shall perform all the necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all the other works necessary for correct jointing. He shall also provide all metal plates, screws, nails and other fixings that may be necessary for doing the specified joinery work properly.

5.3.4 Joints

Where joints are not specifically indicated, they shall be the recognised forms of joints for each position. The joints shall be so made as to comply with Part 2 of BS 1186.

5.3.5 Doors and frames

Door frames, linings, panel doors, framed, ledged and braced doors, flush doors, sliding doors, etc shall be supplied or made by the joiner and shall be installed, fitted or hung as detailed on the Drawings.

All timber shall be wrought and prepared for oiling, staining, varnishing or painting.

5.3.6 Skirtings, cornices, etc

Skirtings, cornices, etc shall not be installed until after the wall coverings have been applied, the flooring laid and ceilings installed, unless otherwise specified.

5.3.7 In-situ joinery

In-situ joinery work shall not be executed until after all floor, wall and ceiling surfaces have been formed or constructed, unless otherwise instructed.

5.3.8 Ceilings

Ceilings shall unless otherwise specified of scheduled consist of plaster board or fibre-cement panels as shown on the Drawings and shall be nailed to the brandering or suspended from the roof structure. The panels shall be separated by exposed tees and insulated with a 50 mm thick fibreglass wool blanket where shown on the Drawings.

The maximum permissible deviations for ceilings shall be as follows, with no abrupt changes accepted:

flatness of the ceiling soffit	:	5 mm measured over a 2 m distance
level of soffit	:	+-10mm

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5.3.9 Timber flooring panels for trench covers

Timber flooring panels (for trench covers) shall consist of meranti planks or laminated meranti panels (as specified) and shall be supplied and installed complete with the steel top hat sections, neoprene strips and support frames indicated on the drawings. Work shall be carried out in a manner consistent with good workmanship and in compliance with the Drawings. The actual dimensions and details measured on site shall be accommodated, and all dimensions to be verified before commencing with any manufacturing or construction.

Steel support frames and top hat sections shall, unless otherwise indicated, be of HDG mild steel and shall meet the requirements of SANS 1200 H. All steel joints (aside from top hat sections which are to remain unfixed) are to be fully welded with no crevices (continuous welding on all sides of any joint).

The gap between the edge of timber flooring and the support frame, top hat section or abutting structure (as applicable) shall be at least 1mm and no greater than 5mm on each side. No gaps shall be left between adjacent panels.

Timber shall meet the semi-clear grade requirements of SANS 1783-3, unless otherwise approved. All timber to be sanded smooth (>240 grit) and sealed all round with Woodoc deck or similar approved sealer (applied in accordance with the manufacturer's instructions). Corners of loose timber planks and complete panels shall be rounded (r≈5mm).

Laminating (gluing) timber planks together to create panels (as applicable) shall be done in accordance with the relevant clauses of SANS 1460. Timber panels are to be machine planed and sanded after laminating to achieve a smooth finish and uniform and correct panel thickness.

Flooring panels shall be mounted firm and level, orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Panel/plank depth shall be within 1mm of the specified depth and adjacent panels/planks shall have vertical edge alignment of within 2 mm of each other.

In cases where the motor control centre (MCC) or variable frequency controllers (VFC) cover parts of the trench, supports and top hat sections shall continue under the MCC\VFC, however the timber flooring panels shall not. Where flooring is supplied with top hats, 40x5mm neoprene strips shall be placed under all flooring edges not supported by a top hat section and adhered with contact adhesive to the angle support.

The tendered rate for timber flooring shall be for the timber flooring, complete and installed with sealer, supports, top hat sections, neoprene strips, etc.

6. ROOF SHEETING AND ACCESSORIES

Roof sheeting and accessories shall comply with and will be measured and paid for under SABS 1200 HB.

7. ELECTRICAL WORK

Electrical work shall be as specified and scheduled by the Electrical Engineer.

The electrical Contractor shall work in close co-operation with the building Contractor to ensure that all conduits, switchboards, plug boxes and switch boxes are installed in their correct position.

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8. PLUMBING

8.1 MATERIALS

8.1.1 General

All materials shall be of the best quality and shall be approved by the Engineer before installation. Cracked, chipped, dented or faulty items or materials shall be replaced at the Contractor's expense. Glazed ceramic sanitary ware shall comply with the requirements of SABS 497 and all other materials shall comply with the standards as specified, scheduled or shown on the Drawings.

8.1.2 Water closet (WC) suites

WC suites shall unless otherwise specified or scheduled consist of a glazed vitreous china closet with an S or P trap and seat lugs, a 14 litre low-level matching flat-bottomed flushing cistern placed and fixed on the closet, or a suspended enamelled cast-iron cistern with the flush pipe connected to the flushing rim of the closet with rubber cone joints, and a solid heavy-duty plastic seat with cover, hinges and buffers.

8.1.3 Urinals

Urinals shall be of the type specified or scheduled, of glazed vitreous china, wall mounted, with an automatic or a manual flushing system, and chromium-plated fittings.

8.1.4 Wash-hand-basins

Wash-hand-basins shall unless otherwise specified or scheduled be of glazed vitreous china or enamelled cast iron, wall mounted on a pair of cast-iron brackets, and fitted with chromium-plated fittings consisting of two taps, outlet and chain, and supplied with a plug and an anti-siphon trap.

8.1.5 Sinks

Sinks shall comply with the requirements of SABS 242 and shall be complete with cabinet, chromium-plated outlet, anti-siphon trap, plug, chain and two bib taps or one mixer tap, all as detailed or as scheduled.

8.1.6 Pipes and tubing

Cast-iron and steel pipes used in plumbing work shall comply with the requirements of SABS 746 and SABS 62 respectively. Copper tubing shall comply with the requirements of SABS 460 and malleable cast-iron fittings with SABS 509.

8.2 CONSTRUCTION

Plumbing shall be carried out strictly in accordance with the Drawings and with the National Building Regulations, with specific reference to Government Notice R1875 dated 31 August 1979.

Steel pipes and their malleable cast-iron fittings shall be joined with red lead and hemp, lead pipes shall have wiped soldered joints, and cast-iron pipes shall be joined by caulking with hemp and metallic lead.

Soil pipes from WC's shall have an internal diameter of at least 100 mm and shall be fitted with a pan connector and an access bend (or an access junction where a vent pipe is

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used), and carried through walls and into the ground for connection to the sewer. Vent pipes shall be fitted with approved balloon gratings.

Waste pipes from basins and sinks shall have an internal diameter of at least 32 mm and shall discharge into gulleys. Bends for waste pipes shall incorporate cleaning eyes.

Cisterns, basins and sinks shall be connected to the pipe system with 12 mm diameter copper service pipes, and chromium-plated stopcocks shall be installed for isolation and maintenance purposes.

9. PAINTING

9.1 GENERAL

No paint shall be applied to any surface containing traces of dust, grit, grease, oil, loose rust, millscale or corrosion products of any kind or to any surface that is not free from moisture. Where necessary, surfaces shall be thoroughly washed to remove all traces of soluble salts and/or corrosive air-borne contaminants prior to painting, and the surfaces shall be dried and painted immediately thereafter.

Welding shall be completed in so far as it is possible before painting commences, but in cases where welding can be done only at a later stage, no paint shall be applied to within 75 mm of the proposed weld position unless otherwise specified. Welds and adjacent parent metal shall be abrasive blasted and/or ground and all contaminants such as flux shall be removed prior to painting.

Surfaces of members which are to rest on concrete or other floors or which will be otherwise inaccessible after erection shall receive the full paint system prior to erection.

Damaged paint areas on metal surfaces shall be cleaned, rust spots removed where applicable and the surrounding paint which is still intact shall be feathered for a distance of 20 mm beyond the damaged area. Spot priming and repair shall consist of all the coats previously applied and shall overlap the damaged area.

Damaged galvanised areas shall be cleaned and any rust spots and any flakes of the coating surrounding the damaged area removed. The coating shall then be restored by zinc spraying or soldering, or painting with a zinc-rich epoxy primer, as may be approved by the Engineer.

Where the shop coat is allowed to age for a few months before the final painting is done, light sanding or rubbing with steel wool or scrubbing with clean water using a bristle brush shall be carried out.

Steel to be embedded in concrete shall not be painted below 50 mm from the final level of the concrete.

Each priming coat and each undercoat of paint shall be inspected and approved by the Engineer before any subsequent undercoat or finishing coat is applied.

All finishing colours shall be as shown on the Drawings, or as directed by the Engineer.

9.2 MATERIALS

Paints shall comply with the requirements of the appropriate Specifications below:

9.2.1 Primers

SABS 678 : For wood

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SABS 679 : Zinc chromate for steel

SABS 723 : Etch-wash primer for metals

SABS 912 : Calcium plumbate for galvanized iron

SABS 926 : Zinc-rich epoxy for steel

9.2.2 Undercoats

SABS 681 : For all undercoats

9.2.3 Finishing coats

SABS 515 : For interior use, flat and egg-shell finish

SABS 630 : For interior and exterior use, high-gloss enamel

SABS 631 : For interior and exterior use, oil gloss paint

SABS 633 : For interior use, emulsion paint

SABS 634 : For exterior use, emulsion paint

SABS 684 : For exterior use on structural steel

SABS 801 : For interior and exterior use, epoxy-tar paint

SABS 802 : For interior and exterior use, bituminous aluminium paint

SABS 887 : For interior use, glossy and egg-shell varnish

The Contractor shall furnish the Engineer with the following information and details regarding the paints and decorative materials for the painting system he proposes to use, for written approval:

a) The name of the manufacturer and trade name

b) The brand, type or grade of paint and the appropriate SABS Specification

c) Manufacturer's data sheets, colour references, instructions for use, including surface preparation, sealers, primers, undercoats, finishing coats, coat thicknesses and curing periods, which shall all be considered as being part of these Specifications if approved by the Engineer

d) Safeguards to protect the applied paint from damage until the work is accepted by the Engineer

e) The shelf or pot life of materials, if applicable

f) An undertaking that the proposed paint system is suitable for its intended use and that the various coats of paint are compatible with one another

Where proprietary brands are used, the manufacturer's priming and all subsequent coats of paint suitable for that particular brand shall be employed in accordance with the manufacturer's instructions.

No other materials of a similar nature and quality or from another manufacturer may be used instead of those approved, unless written permission to do so has been obtained from the Engineer.

All materials shall be brought onto the Site in containers sealed by the manufacturer. Paints of a different quality, type, brand or colour shall not be mixed. Paint shall not be thinned

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nor adulterated in any way, but shall be used as supplied by the manufacturer. Any mixing or tinting required shall be carried out by the manufacturer.

Tinting of paint on the Site by the Contractor will only be allowed with the written permission of the manufacturer and the Engineer.

9.3 INSPECTION AND PRELIMINARY WORK

Before commencing paintwork, the Contractor shall carefully inspect the surfaces to be painted to satisfy himself that the surfaces are in a satisfactory or acceptable condition to receive the paint system specified.

All metal fittings and fastenings shall be removed where applicable before the preparatory processes are commenced. On completion, the metal fittings and fastenings shall be cleaned and refitted in position.

9.4 WORKMANSHIP AND FINISHES

Paint may be applied by spray, brush or roller depending on the materials used, the surface to be painted, and the manufacturer's instructions.

Every coat of paint, irrespective of the method of application, shall be adequately and permanently keyed or bonded to the base material or previously applied coat, and shall be evenly distributed, continuous, free from sags, runs, brush marks, pin holes or other imperfections, and shall dry to a smooth finish.

An approved water trap and air-regulating valve shall be furnished and installed on all equipment used in spray painting.

Before painting the interiors of buildings they shall be cleaned and the floors shall be washed and kept free from dust during the progress of the interior work.

The Contractor shall protect all nearby surfaces against disfigurement by spatters, splashes and smirches of paint or paint materials. The Contractor shall be responsible for any damage by paint or dirt caused by his operations to vehicles or property or injury to persons and he will be required to provide protective measures to prevent any such damage or injury and make good, where required, at his own expense.

If passing traffic creates dust which may harm or spoil the appearance of external painted surfaces, the Contractor shall sprinkle the adjacent areas with water, at his own cost, for a sufficient distance on each side of the location where painting is being done.

Undercoats shall be tinted by the manufacturer to distinguish between successive coats.

The final coats or finishing coats of paint shall be applied after all the other work in the vicinity has been completed.

The painter shall keep some of the final paint in reserve in the event of his having to make good any patching which may be required as a result of damage or unforeseen circumstances.

Upon completion, the Contractor shall, in the case of buildings, clean all glass, remove all paint spots from walls, floors and fittings, and leave the premises clean and fit for occupation.

All inflammable materials, comprising solvents, thinners, wiping cloths, etc, shall be placed in tightly closed containers and properly disposed of.

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9.5 PAINTING OF PLASTER, CONCRETE OR BRICK SURFACES

9.5.1 Surface preparation

Surfaces for painting shall be prepared by sandpapering, scraping or wire-brushing to remove loose material, dust, laitance, scum or other deleterious materials or high spots. Defective areas shall be cut out where necessary and made good with an approved non-shrink filler. Cracks shall be cut out, suitably keyed, and given a coat of an approved bonding agent before the filler is applied. All patches shall be rubbed down to an even surface. Surfaces shall be washed and allowed to dry.

Surfaces shall be treated with neutralising liquid for walls, and if the surface is coarse or textured, either one full coat of pigmented wall sealer or one full filler coat shall be applied in addition to the neutralising liquid.

9.5.2 Paint application

Prior to the emulsion paint being applied, the surface shall be sealed with an approved clear sealer and primed with an undercoat diluted to 50%. Emulsion paint (PVA or acrylic) shall then be applied in two finishing coats.

Egg-shell finish (alkyd oil-based), oil gloss paint or enamel gloss paint shall be applied as follows: one coat of universal undercoat shall be applied and it shall be followed by one coat of a mixture comprising 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of semi-gloss egg-shell, or oil gloss paint or enamel gloss paint shall then be applied.

9.6 PAINTING OF WOODWORK

9.6.1 Surface preparation

The surfaces shall be cleaned, sandpapered and rubbed down to a smooth, even face before painting. The moisture content of the timber shall not be more than 20% at the time when the first coat is applied. All cracks, shakes or scars shall be filled flush with a filler approved by the Engineer before painting. The surface shall then be washed with cleaner and allowed to dry.

9.6.2 Primer application

One coat of an approved wood primer shall be applied.

After timber has been prepared and primed, stopping and filling shall be done in accordance with SANS 10305-2, followed by sanding the stopped and filled areas with a fine-grit sandpaper to smooth the surface. Careful attention shall be paid to stopping and sealing rough, open-textured or coarse grained surfaces, and sealing joints, that may lead to water ingress, with a flexible sealer. Stopper/filler/sealer manufacturer's instructions should be strictly followed.

All new woodwork shall be properly primed on all surfaces and edges before being fixed in position. All woodwork not previously painted shall be given a prime coat, well brushed in.

9.6.3 Paint application

One coat of universal undercoat shall be applied followed by one coat of a mixture of 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of

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oil gloss paint or enamel gloss paint or semi-gloss egg-shell (alkyd oil-based) paint shall then be applied.

9.6.4 Varnish finish

Two coats of gloss varnish or egg-shell varnish shall be prepared, stopped and applied.

9.7 PAINTING OF METAL SURFACES

9.7.1 General

Wherever possible, all painting shall be done at the manufacturer's works, but where this is not feasible, the Engineer may permit the application of the undercoat and finishing coats to be carried out on the Site, in which case a prime coat shall be applied at the manufacturer's works prior to the members being despatched to the Works.

9.7.2 Surface preparation

The preparation of metal surfaces shall comply with SABS Code of Practice 064 and shall receive the greatest care to ensure rust-free conditions prior to the paint system being applied.

All surfaces shall be prepared by removing loose paint, rust, plaster, scale, dust, dirt, grease, etc and by repairing or patching defective paint surfaces before painting or repainting. Damaged shop-primed surfaces shall be thoroughly cleaned of rust and patched with a prime coat.

9.7.3 Paint application

a) Iron and steel work

All iron and steel work shall be properly primed with a red-lead-based primer where steel work is likely to be exposed to the elements for longer than 30 days. Zinc-chromate primer may be used where overpainting will be completed within 30 days of priming. Metal-etch wash primers may be used under dry conditions where overpainting will be completed within 24 hours of priming. The dry-film thickness of the prime coat shall not be less than 0,300 mm.

After priming, one coat of universal undercoat shall be applied. If necessary, the undercoat shall be tinted to a shade just lighter than the desired finish with approved liquid stainers. The dry-film thickness shall not be less than 0,250 mm.

The two finishing coats shall either be of alkyd resin-based synthetic enamel, gloss or matt oil paint, or as specified elsewhere. The dry-film thickness shall not be less than 0,250 mm per coat.

When mating surfaces are brought together, both surfaces shall have been given the full treatment specified, but where this cannot be done, each surface shall be given a copious coating of primer and the surfaces drawn together while the paint is still wet.

The portion of structural steel members to be buried in soil, and all bases to a height of 500 mm shall be given two coats of an epoxy-tar primer instead of the zinc-chromate primer specified for other surfaces.

The surfaces of steel and cast-iron articles, such as floor gratings, grids and manhole covers, shall, after a thorough brushing to remove loose rust, be painted with two coats of epoxy-tar paint, each at least 0,230 mm thick.

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b) Galvanized iron and steel

All traces of protective coating shall be removed with galvanized iron cleaner, and two coats of calcium plumbate primer shall be applied. One coat of tinted universal undercoat and two finishing coats of alkyd resin-based synthetic enamel gloss paint shall be applied.

c) Non-ferrous metals

Surfaces of aluminium, copper, etc shall be prepared and cleaned, and one coat of self-etch zinc-chromate wash primer shall be applied. One coat of universal tinted undercoat and two finishing coats of enamel gloss paint shall then be applied. Where non-ferrous metals are not to be painted, the surfaces shall be cleaned, polished and two coats of lacquer applied.

9.8 PAINTING OF FLOOR SCREEDS

Where chemicals could cause damage to floors or where specified, such floors shall, unless otherwise indicated, be painted with an approved epoxy paint. The type of paint to be used will be shown on the Drawings and will depend on the types of chemical that are used.

The preparation of such floor screeds for painting and the subsequent application of paints shall be carried out strictly in accordance with the manufacturer's instructions.

9.9 PAINT THICKNESS

Unless otherwise specified, all coats of paint, whether prime coat, undercoat or finishing coat, shall have a dry-film thickness of not less than 0,200 mm, irrespective of the method of application.

9.10 INSPECTION

The Contractor shall provide the necessary equipment to establish whether the primers, undercoats and finishing coats have been applied to the correct thickness according to the correct applications. The Engineer may take samples of the paints during painting operations for testing and quality control.

10. MEASUREMENT AND PAYMENT

10.1 BRICKWORK

(1) (Indication of thickness, type, class, and if plastering and painting is required) ..... Unit: m²

(2) Etc for other thicknesses, types, classes and plastering, painting requirements.

The unit of measurement shall generally be the square metre of each type of brickwork built, calculated from the leading dimensions of the brickwork. Deductions will be made for doors, windows and other openings of similar dimensions. At corners and intersections common to more than one brick wall, the areas shall be measured only once.

The tendered rates shall include full compensation for the construction of the brickwork complete as specified, including pointing, lintels, weepholes, waterproofing to cavity walls (i.e. sloping infill adjacent weepholes with damp-proof course or torch-on etc.), expansion/control joints, masonry-to-concrete joints, wall ties, brickforce reinforcement, the raking-out of joints, etc., and, when scheduled, shall also include plasterwork, facings, paintwork, concrete infill, etc. The rates shall further include the building-in of pipework, conduits, sleeves, doors, windows, etc. The reference panel shall not be measured or paid for separately but shall be deemed to be included in the brickwork rates.

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10.2 PLASTERWORK

(1) (Thickness of plaster and finish indicated)..... Unit: m²

(2) Etc for other thicknesses and finishes

The unit of measurement shall be the square metre of each type of coat completed as specified.

The tendered rates shall include full compensation for the construction of the plasterwork, including supplying all materials, mixing, applying, finishing, forming reveals, joints, narrow widths, rounded angles, V-joints, etc complete as specified.

Where brickwork is scheduled to include plasterwork (i.e. plasterwork is to be included in the brickwork rate, see 10.1), then plasterwork will not also be measured here.

Note: Where brickwork is scheduled to include plasterwork (i.e. plasterwork is to be included in the brickwork rate (see 10.1), then plasterwork will not also be measured here. Other rates may similarly also include plasterwork, in which case plasterwork will not also be measured here.

10.3 ROOF FINISHES

(1) Roof screed (fall and avg. thickness if applicable)..... Unit: m²

(2) Crushed stone to roof slab (avg. thickness if applicable). ..... Unit: m²

(3) Torch-on Waterproofing (description as applicable). ..... Unit: m²

(4) Etc ..... Unit: m²

The unit of measurement shall be the square metre of roof finish applied, as specified, on areas shown on the Drawings or as designated by the Engineer.

Different roof finishes shall be scheduled separately. The tendered rates shall include full compensation for constructing and completing the roof finish, including supplying all materials, mixing, laying, placing finishing, curing and forming joints and edges, etc.

Floor screeds and finishes shall not be measured here but under the relevant Subclause of SANS 1200 G.

10.4 DOORS, WINDOWS, LOUVRES, ETC.

(1) (Type and size indicated) ..... Unit: number

(2) Etc for other types and sizes

The unit of measurement shall be the number of doors, windows and louvres installed complete as specified.

The tendered rates shall include full compensation for manufacturing and installing the door, window and louvre, complete, whether of wood, steel, aluminium or other materials. The rate shall include the frames, hinges, handles, locks, keys, barrel bolts, door closers, retaining devices, door stops, stays and any other work or ironmongery necessary to complete the work as specified or as shown on the Drawings. The tendered rate for doors, windows, louvres, etc. shall further include full compensation for any coatings/finish required (oiling, staining, varnishing, painting, calking, sealing, etc.), corrosion protection, glazing, window sills (unless scheduled separately), thresholds as specified and all necessary subframes.

10.5 CEILINGS AND BULKHEADS

(1) Plaster-board ceiling (type and thickness indicated):

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a) Fixed ceiling ..... Unit: m²

b) Suspended ceiling ..... Unit: m²

(2) Fibre-cement ceiling (thickness indicated):

a) Fixed ceiling ..... Unit: m²

b) Suspended ceiling ..... Unit: m²

(3) Etc for other types of ceilings

(4) Bulkheads (description of material and indication of vertical or horizontal) ..... Unit: m²

(5) Cornices (description) ..... Unit: m

The unit of measurement shall be the square metre of fixed or suspended ceiling or bulkheads installed complete as scheduled. The unit of measurement for cornices shall be linear metre.

The tendered rates shall include full compensation for the construction of the ceilings, bulkheads and cornices as scheduled. The rate shall also include for, as applicable and not limited to, the exposed tees, grids, frameworks, hangers, trap doors, taping and filling joints, skimming, painting, insulation blanket and brandering as specified, as well as the suspension system where applicable.

10.6 CARPENTRY AND JOINERY

(1) Cupboards and countertops (details indicated)

(2) Skirtings (details indicated)

(3) Timber flooring, complete with supports (details indicated)

(4) Shower/toilet cubicles (details indicated)

(5) Timber roof structure (details indicated)

(6) Etc for other items

The unit of measurement shall be as scheduled.

The tendered rates shall include full compensation for supplying all materials, and manufacturing, cutting, wasting, applying the required finish (i.e. painting, varnishing, etc.), fixing, building-in and installing the items, and shall include all required fasteners, clips, tie-downs and straps, etc. Tendered rates shall also include for all ancillaries and accessories specified, such as specified ironmongery, granite tabletops, glass viewing panels in cupboard doors, etc.

Timber flooring shall be measured as the total area covered by the timber flooring panels (excluding areas covered by the MCC or VFCs). The rate for timber flooring shall further include the cost of supplying the specified or scheduled steel top hat sections (unfixed), angle support frames (including added flat bars where required) and neoprene strips as indicated on the drawings and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of shop drawings/details for the steel items (where required), all procurement costs, fabrication, cutting, welding, corrosion protection (such as galvanizing and painting) as specified, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the flooring, support frames, top hat sections, etc.

10.7 MISCELLANEOUS

(1) Plumbing

(2) Etc

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The unit of measurement shall be as scheduled.

The tendered sums or rates shall cover all costs required to complete the work and activities as scheduled and specified, and are to include for items and activities ancillary to the work. This shall, for example, include full compensation for the supply of all materials (including anchor fasteners and corrosion protection), manufacturing/providing, delivery to site, storage, all equipment and plant, labour, preparation, application, installation, applying finishes, testing, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion.

Note: Where brickwork is scheduled to include paintwork (i.e. paintwork is to be included in the brickwork rate (see 10.1), then paintwork will not also be measured here. Other rates such as ceilings and bulkheads may similarly also include paintwork, in which case paintwork will not also be measured here.

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PARTICULAR SPECIFICATION PZ: REPAIR WORK TO STRUCTURAL CONCRETE

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PZ 1 SCOPE

This specification covers all repair/remedial/refurbishment/protective-lining work to concrete in connection with demolition, breaking, cutting, surface preparation, reprofiling, and the application of protective coatings/linings to concrete.

PZ 2 DEFINITIONS/ABBREVIATIONS

Reprofiling: Application of a re-building cementitious (or similar) mortar or micro-concrete to return a concrete surface (typically with exposed aggregate from deterioration/damage) to its original finish (line and quality/finish) and to reinstate the original concrete cover.

Supplier: The manufacturer of proprietary protective lining or concrete repair products.

PZ 3 MATERIALS

PZ 3.1 General

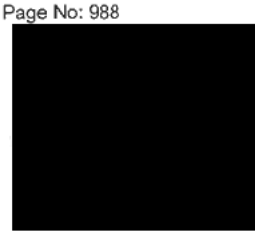
All materials used in respect of this specification shall be proprietary products from reputable Suppliers with a proven history of successful use for the purposes required in the environment in which they are to be installed. Where alternative products are proposed by the Contractor, the Engineer may request proof of successful use of such products in similar environments.

PZ 3.2 Guarantees

The systems installed shall be guaranteed by the Contractor and backed by the Supplier for a minimum of 10 years. The guarantee shall cover both the product and the workmanship for 10 years. Proof of the intention to supply such a guarantee shall be provided to the Engineer prior to the commencement of the works on site.

The installers of proprietary products shall be Supplier-approved applicators with a proven history of successful use of the products specified.

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It is assumed that the Supplier's representative will play an active role in inspecting the works on site from time to time as may be deemed necessary to ensure compliance in terms of the guarantee to be provided.

PZ 3.3 Trial panels

The Engineer may instruct that trial-panels (1mx1m) of any of the systems described in this specification (or alternatives that the Contractor proposes) be prepared on site for the purpose of discussion, further testing, approval or as a basis of acceptance for surface finishes etc. The cost for such trial panels are to be measured and paid for as per the various measurement items in section PZ8 where the trial panel is deemed acceptable by the Engineer.

PZ 4 EQUIPMENT

PZ 4.1 Demolition Equipment

All devices used to remove concrete, cut concrete or to demolish concrete members, shall be handled, stored and used strictly in accordance with the manufacturer's instructions and current safety regulations.

PZ 4.2 Mixing and Preparation Equipment

All plant and equipment used for the preparation of concrete surfaces, batching of material and mixing operations shall be in good working order and suited for the intended use. The plant shall be inspected, serviced and calibrated at regular intervals and tested to ensure proper functioning, all to the satisfaction of the Engineer.

PZ 4.3 Specialist Spraying/Shotcreting/Pumping Equipment

All spraying/shotcreting/pumping equipment shall be the proprietary product's recommended sprayer, and shall be inspected, serviced and calibrated at regular intervals and tested to ensure proper functioning, all to the satisfaction of the Supplier and Engineer.

PZ 4.4 Access Equipment

All scaffolding or similar access equipment shall be suitable and safe for the intended use, and compliant with the local health and safety legislation/regulations.

PZ 5 EXECUTION OF WORKS

PZ 5.1 Storing of materials

The Contractor shall provide a lock-up store for the all materials and observe all storage requirements and safety precautions recommended by the materials manufactureres (especially relating to temperature, moisture control and product life-span requirements).

PZ 5.2 Demolition of concrete

The method and sequence of demolition (as well as temporary propping where necessary) shall be submitted to the Engineer for approval. Screening and protective measures shall be established around the work area as necessary to ensure acceptable environmental, health and safety conditions.

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The contractor shall ensure that any nuisance associated with his work activity is minimised by implementing appropriate precautions and measures to the approval of the engineer. Common nuisances associated with demolition and concrete removal include fumes, noise, dust, flying fragments, heat and vibration.

All waste materials, rubble, scrap and rubbish arising from the contractor's presence on site and / or the execution of the works shall be disposed of weekly to a disposal site identified by the Contractor and approved by the Engineer.

PZ 5.3 Preparation of concrete surfaces/construction joints

All surface laitance and damaged, loose and soft concrete, concrete containing aggressive ions (e.g. chlorides, sulphates), as well as all foreign materials such as oil, paint, grease, etc. shall be removed from the contact surface using a suitable method that may include:

- pneumatic chisels,
- sand blasting,
- wet-grit blasting,
- high-pressure water-jetting,
- Any combination of the above

The intention of the preparation is to leave a clean, sound, exposed aggregate finish to the concrete surface that is suitable for the bonding requirement of the subsequent layer/lining. Dust shall be removed from the final finish by water-jetting/washing. Care shall also be taken so as not to remove more concrete than is necessary (so as not to reduce existing cover unnecessarily).

Where required by the subsequent lining/layer, the pH of the prepared substrate shall comply with the lining-product's specification. Where the pH of the prepared surface is not suitable after initial preparation, the surface is to be further prepared by means of the above method(s) until a suitable pH is achieved comprehensively.

The area to be repaired shall be bounded by straight line edges cut to the required depth (for the re-profiling mortars) using a diamond cutting saw, angle grinder or other approved equipment. The edges shall be recessed such that the repair/reprofile has a thickness at the edge of at least twice the maximum aggregate size of the patching material, but in any case not less than 10 mm.

It is expected that Contractors are familiar with the products that are specified and therefore the requirements of surface preparation as required by the Suppliers. The final prepared surface shall be to the approval of the Engineer and Supplier of subsequent linings.

The smooth cutting edge/surface of the saw-cut shall be roughened by wire-brushing to aid the repair-material bond.

PZ 5.4 Preparation of exposed reinforcing

All exposed reinforcing in repair areas is to be wire-brushed (using an angle-grinder with a wire-cup brush) to remove loose surface corrosion and to provide a clean steel substrate free of corrosion product.

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The Contractor shall at the beginning of the works prepare a sample for the Engineer's approval that shall serve as a basis of acceptance for prepared reinforcing.

Cleaned reinforcing is then to be coated with an approved anti-corrosion epoxy resin coating suitable for reinforcing.

Where significant pitting corrosion of the existing reinforcing is encountered (i.e. visible loss of cross-sectional area of reinforcing bar), this is to be brought to the attention of the Engineer for further instruction.

PZ 5.5 Bonding agents

Where bonding agents are specified or proposed, they are to be used **strictly** within the active window-periods stated by the Supplier, taking note of site conditions (temperature, humidity etc.).

PZ 5.6 Curing of repair linings

Curing of all linings/repairs is to be done rigorously by an approved method to prevent moisture loss from the repair during the early age of the product. This may require physical covering and/or the application of mist-sprays until a period where the lining/repair is not susceptible to cracking. Cracked linings will not be accepted and will need to be removed/repaired to a method acceptable to the Engineer. The curing periods of linings shall be as per the Supplier's specifications.

PZ 5.7 Repair mortars/concretes

PZ 5.7.1 Epoxy resin repairs

Surface repairs less than 5mm deep shall be repaired with a proprietary structural repair epoxy resin (Sikadur 31 DW or equivalent approved) to exact Supplier's specifications.

The structural repair epoxy shall achieve a compressive strength of at least 50MPa at 14 days.

The repair epoxy should be suitable for the trafficking of mechanical rotating bridge wheel loads where applicable.

The applied product shall achieve the specified strength prior to loading/watertightness testing.

PZ 5.7.2 Shallow localised repairs

Shallow localised repairs (i.e. up to 50mm deep) shall be filled with an approved proprietary polymer-modified structural repair-mortar / grout (Sika Monocp 615 HB, or ABE Dureprep FR or equivalent approved) to exact Supplier's specifications. Bonding agents shall be used as per PZ 5.5.

Repairs should be carried out in a manner that ensures no sagging of the repair mortar (on vertical and overhead applications). Curing shall be rigorously applied to Supplier's specifications.

The structural repair mortar should be able to be applied in a single application only. Multiple layered repairs will not be accepted.

The structural repair mortar shall achieve a compressive strength of at least 35MPa at 28 days.

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The repair area should be bounded by a 10mm deep sawcut to ensure no feathering of the repair mortar at the edge (Noting the requirements of PZ 5.3)

The applied product shall achieve the specified strength prior to loading/watertightness testing.

PZ 5.7.3 Micro-concrete repairs

Deep localised repairs (i.e. greater than 50mm deep) shall be filled with a proprietary micro-concrete (Sikagrout 212, or ABE Durarep FMC or equivalent approved) with 6mm or 13mm aggregate to exact Supplier's specifications.

The structural repair concrete shall achieve a compressive strength of at least 40MPa at 7 days.

No bonding agent shall be used, and formwork shall be applied to vertical and overhead applications. Compaction and curing shall be rigorously applied to Supplier's specifications.

The repair area should be bounded by a sawcut (at least twice the aggregate size in depth, noting also the requirements of PZ 5.3)

The applied product shall achieve the specified strength prior to loading/watertightness testing.

PZ 5.7.4 Reprofiling of concrete surfaces

Concrete shall be reprofiled using a structural polymer-modified reprofiling mortar (Sika Monotop 615 HB or equivalent approved) to exact manufacturer's specifications, but as a minimum requirement should be suitable for application thicknesses of 10 to 40mm thick (with localised thicknesses reducing to 5mm minimum thickness at protruding aggregate). Bonding agents shall be used as per PZ 5.5 and the minimum (and maximum) thicknesses of the product shall be adhered to.

The repair area should be bounded by a 10mm deep sawcut to ensure no feathering of the repair mortar at the edge (noting also the requirements of PZ 5.3).

The applied product shall achieve the specified strength prior to loading/watertightness testing.

PZ 5.7.5 Reprofiling with Calcium Aluminate Cement (CAC) lining

Concrete shall be reprofiled using a 100% CAC lining (Imerys Fondag, or Sika Monotop 4400 MIC or equivalent approved) to an average thickness of 25mm (unless otherwise stated) by means of a low pressure wet shotcrete pump.

The repair area should be bounded by a 25mm deep sawcut to ensure no feathering of the repair mortar at the edge.

PZ 5.8 Protective polymer linings

All protective polymer linings specified shall be applied strictly to all the Supplier's specifications, taking special note of the site and substrate conditions (moisture content of parent material, temperature, humidity etc.).

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All matters relating to the successful application of the linings (Primers, day-joint preparation and positions, window periods, reactivation procedures etc.) shall be as per the Supplier's specifications.

PZ 5.9 Migrating corrosion inhibitors

The suitability of migrating corrosion inhibitors shall be proven by the industry track-record provided by the Supplier. The concrete surface should be suitably prepared before the application of a migrating corrosion inhibitor, and should be washed down with clean water after the application.

The suitability of migrating corrosion inhibitors shall be proven by the industry track-record provided by the supplier. The ingress of migrating corrosion inhibitors shall be measurable. The concrete surface should be suitably prepared before the application of a migrating corrosion inhibitor, and should be washed down with clean water after the application.

PZ 5.10 Installation of sacrificial anodes

Where concrete patch-repairs are carried out, the adjacent (unrepaired) concrete shall be treated by means of sacrificial anodes installed at reinforcing level by a reputable supplier with a proven product (Sika Ferrogard Patch 62gm anode complete with Sika duocrete anchor mortar or equivalent approved).

Anodes should have a minimum influence radius of at least 750mm and should be installed around the repaired area to ensure 100mm overlapping of influence areas at the edge of the repair.

PZ 5.11 Crack injection

Crack-injection shall be low-viscosity epoxy inserted into cracks with pressure pumps/guns after sealing the outside edge of the crack(s) with an approved epoxy (Sikadur52ZA or equivalent approved). Injection ports, port spacing and pumps are to be Supplier-approved.

PZ 5.12 Repair of leaks by means of crystallising cementitious repair

Cracks/defects shall be sealed by an approved proprietary cementitious crystallising waterproofing system that reacts with the leaking water to seal the leak. Cracks/defects shall ideally be treated from the dry side of the concrete element while the structure is filled to its service level. Products should be suitable to seal actively leaking cracks. The preparation of the crack/defect shall be strictly to the Supplier's guidelines.

PZ 5.13 Application of a joint-bridging flexible waterstop

Flexible bandage / waterstops to seal joints should be epoxied to the concrete substrate on either side of the joint using a Supplier-approved epoxy. Preparation of the substrates should ensure good bond, and lapping shall be as per Supplier's details.

Flexible bandage / waterstop should be able to handle differential movement of 10mm in shear and tension (combined) unless otherwise noted, and shall be a minimum of 2mm thick and width as specified nut minimum 200mm.

Flexible bandage / waterstops should be 100% UV stable (apart from discolouration) and suitable for the environment in which they are to be installed.

PZ 5.14 Installation of epoxy-dowels

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Reinforcing dowels shall be anchored using a suitable epoxy suitable for reinforcing steel. All dowelling works shall be to exact Suppliers specifications, noting especially the requirements of hole drilling, preparation, cleanness and moisture content.

When drilling into existing concrete, drill-bits capable of cutting reinforcing steel shall not be permitted.

The minimum anchorage depths for various bars shall be as follows:

Y/R10: 100mm

Y12: 150mm

Y16: 200mm

Y20: 250mm

PZ 6 TOLERANCES

Tolerances shall be as per the Supplier's specifications. Where not stated by the Supplier, tolerances shall be as per SANS1200G (as amended by PSG when applicable).

PZ 7 TESTING

PZ 7.1 General

The testing of repairs and linings shall be as per the Supplier's recommendations and shall be deemed to be included in the cost of the lining/repair if not separately measured in Section PZ 8.

Tests instructed by the Engineer as detailed in PZ 8 will only be paid for where successful (as far as it pertains to the Contractor's installed works).

PZ 7.2 **Sounding survey**

All reprofiled/repaired surfaces are to be tested by means of a comprehensive sounding survey.

This shall be done by means of tapping hammer of approximately 1kg mass on the reprofiled surface and recording the location of hollow sounding areas.

On plane areas of concrete the surface shall be sounded at approximately 300 mm centres in each direction. On columns, beams or other similar members with faces less than 300 mm wide, each face shall be sounded near each edge or corner at approximately 300 mm centres along the member.

Where a hollow sounding area is detected its extent shall be determined by local sounding and its periphery marked on the surface of the member. Such defective areas are then to be removed and repaired. Defective/unbonded areas shall not be paid for until the sounding survey is successfully completed.

PZ 7.3 Holiday testing

Holiday testing shall be carried out by a competent independent testing body with equipment suitable to test linings applied to reinforced concrete substrates.

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Problematic pinholes/areas are to be marked out for repair. Defective/unbonded areas shall not be paid for until the holiday test is successfully completed.

PZ 7.4 Repair mortars/micro-concrete

The Engineer may request that repair products be tested by means of concrete compressive tests at 28 days to ensure compliance with Supplier's specifications.

PZ 7.5 Pull-out Testing of Dowels

The Engineer may request that pull-out tests be performed on reinforcing bars that are epoxy-anchored into the concrete to confirm that the dowelling method/product is performed to the Supplier's specifications and achieves the Engineer's specified loads. The pull-out testing is preferably to be done by the epoxy Supplier. The Engineer shall select bars to be tested and shall state the pull-out test load in each case.

PZ 8 MEASUREMENT AND PAYMENT

The payment items below shall include full compensation to complete the demolition, preparation, repair and lining activities described in this specification PZ.

The quantities indicated in the Schedule of Quantities under this section are based on inspections carried out as part of the preliminary and detail design phases, increased to allow for unforeseen work and defects that were not visible. The actual works to be executed may vary from the scheduled quantities and the Contractor shall be deemed to have allowed in his tendered rates for such variations as far as can be reasonably expected.

All quantities are to be verified on site by the Engineer's representative prior to the placing of the repair products. Where products are measured by volume or mass, the Engineers' representative is to countersign the actual amount of material used on site for measurement and certification.

New reinforcement will be measured separately.

PZ 8.1 Demolition of concrete elements **Unit: m^3**

The unit of measurement is the cubic metre of concrete (reinforced or unreinforced) demolished, measured in its original position and shape based on:

(i) Full demolition

(ii) Partial demolition

The tendered rate shall include full compensation for all labour, material, screening of the structure for safety and environmental protective measures, equipment and plant as well as for all work and incidentals required to complete the work as specified and required to demolish the concrete member and to load, transport and dump the concrete segments and rubble at the nearest approved dumping site.

PZ 8.2 Dowelling of reinforcing into concrete (bar diameter stated) Unit: No

The unit of measurement shall be the number of dowels installed. The tendered rate shall include full compensation for all labour, materials, equipment, required for the drilling and anchoring of reinforcing bars into existing concrete with a suitable epoxy grout (Fischer EM Injection grout, Hilti HIT HY200, Sika Anchorfix III or similar

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approved). Reinforcing bars will be measured elsewhere. All doweling works shall be to exact manufacturer's specifications. The minimum anchorage depths for various bars shall be as per PZ 5.14 unless otherwise stated.

PZ 8.3 Preparation of concrete surfaces/construction joints for reprofiling **Unit: m²**

The unit of measurement shall be the square metres of concrete prepared.

The tendered rate shall include full compensation for all labour, materials, equipment, required for preparing concrete surfaces for reprofiling to specification, as well as removal of all waste materials from the site to the nearest approved dumping site.

PZ 8.4 Preparation of exposed reinforcing (bar diameter stated) **Unit: m**

The unit of measurement shall be the length in metres of reinforcing bar prepared.

The tendered rate shall include full compensation for all labour, materials, equipment, required for cleaning and treating of old reinforcing bars with a bonding agent and anti-corrosion coating for structural repairs (Sika Armatec 110EC or equivalent approved).

PZ 8.5 Application of a bonding agent for repair/reprofiling mortars **Unit: m²**

The unit of measurement shall be the square metres of bonding agent applied to a repair surface.

The tendered rate shall include full compensation for all labour, materials, equipment, required for applying a bonding agent for structural repairs (Sika Armatec 110EC or equivalent approved).

PZ 8.6 Application of a migrating corrosion inhibitor **Unit: m²**

The unit of measurement shall be the square metres of migrating corrosion inhibitor applied to a repair surface.

The tendered rate shall include full compensation for all labour, materials, equipment, required for applying a migrating corrosion inhibitor to a repair surface (Sika Ferrogard 903+, or ABE MuCis mia 100, or equivalent approved).

PZ 8.7 Installation of sacrificial anodes **Unit: No.**

The unit of measurement shall be the number of sacrificial anodes installed complete and connected to concrete reinforcing.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing sacrificial anodes complete with anchor mortar to concrete reinforcing (Sika Ferrogard Patch 62gm anodes complete with Sika Duocrete anchor mortar, or equivalent approved system).

PZ 8.8 Epoxy resin repairs to concrete (surface repairs) **Unit: ℓ**

The unit of measurement shall be the litres of epoxy repair resin applied to concrete surfaces.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable epoxy resin mortar to shallow concrete surface repairs (Sikadur 31 DW or equivalent approved).

PZ 8.9 Shallow localised repairs to concrete **Unit: ℓ**

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The unit of measurement shall be the litres of structural repair mortar applied to (localised) concrete repair surfaces.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable structural repair mortar to shallow repairs (Sika Monotop 615HB, or ABE Durarep FR, or equivalent approved).

PZ 8.10 Micro-concrete repairs **Unit: ℓ**

The unit of measurement shall be the litre of structural micro-concrete applied to concrete repair surfaces.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable structural micro-concrete to deep repairs (Sikagrout 212, with added coarse aggregate, or ABE Durarep FMC, with added coarse aggregate, or equivalent approved).

PZ 8.11 Reprofiling of Concrete surfaces (thickness stated) **Unit: ℓ**

The unit of measurement shall be the litres of concrete reprofiled to a specified minimum thickness.

The tendered rate shall include full compensation for all labour, materials, equipment, required for reprofiling of concrete surface using suitable cementitious reprofiling mortar (Sika Monotop 615HB, or ABE Durarep FR, or equivalent approved). The tendered rate shall include all testing as described in this specification.

PZ 8.12 Installation of crack-injection epoxy (wall thickness stated) **Unit: ℓ**

The unit of measurement shall be the litre of crack-injection epoxy installed.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable crack-injection epoxy for crack sealing (Sikadur 52ZA or equivalent approved).

PZ 8.13 Installation of protective polymer linings to concrete (Product and thickness stated) **Unit: m^2**

The unit of measurement shall be the square metres of surface treated. The rate shall include all primers/activation products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing of the product stated (or equivalent approved) to the thickness stated.

PZ 8.14 Installation of a Calcium Aluminate Cement (CAC) reprofiling lining to concrete **Unit: m^2**

The unit of measurement shall be the square metres of surface reprofiled to an average thickness of 25mm. The rate shall include all primers/activation products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable CAC lining to the thickness stated (Imerys Fondag, or Sika Monotop 4400 MIC, or equivalent approved). The tendered rate shall include all testing as described in this specification.

PZ 8.15 Sealing of active leaks in concrete tanks by means of specialist cementitious crystallising products **Unit: ℓ / kg**

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The unit of measurement shall be the litre or kilogram of product applied to seal/waterproof defects. The rate shall include all preparation and products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for the defect preparation and sealing/waterproofing of defects with a suitable cementitious crystallising product (Xypex Patch and Plug, or Penetron Slurry/Penecrete, or Kryton Plug/Repair Grout, or equivalent approved) to all Supplier's requirements.

PZ 8.16 Installation of joint-bridging flexible bandages **Unit: m**

The unit of measurement shall be the linear meter of product installed.

The tendered rate shall include full compensation for all labour, materials, equipment, required for sealing of the joint with suiable joint-bridiging flexible bandage with a minimum width of 200mm (Sikadur Combiflex SG-20 P, or ABE Durajoint Flexband , or Schomburg ASO-Tape , or equivalent approved), including all necessary preparation and required proprietary products, including but not limited to required anchoring adhesive.

PZ 8.17 Perform holiday testing to protective linings **Unit: m^2**

The unit of measurement shall be the square metres of lining tested.

The tendered rate shall include full compensation for all labour, materials, equipment, required for holiday testing of protective linings.

PZ 8.18 Perform pull-out testing to epoxied reinforcing dowels **Unit: No.**

The unit of measurement shall be the number of dowels tested (up to 20mm diameter).

The tendered rate shall include full compensation for all labour, materials, equipment, required for the testing.

PZ 8.19 Cut out of existing walls **Unit: No.**

The unit of measurement shall be the length to be removed with thickness of the wall stated:

The tendered rate shall include full compensation for neatly cutting away existing walls and removing concrete and structural steel reinforcement and disposing off site by contractor. The tendered rate shall include full compensation for all labour, materials, equipment, required for the cut outs.

PZ 8.20 Block existing pipes flet and out pipes and provide a watertight seal — Units: No.

The unit of measurement shall be the number of pipes to be blocked:

The tendered rate shall include full compensation for blocking off existing pipes and providing a water tight seal in the structure. The tendered rate shall include full compensation for all labour, materials, equipment, required for the blocking off of pipes.

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MULDERSVLEI 300ML RESERVOIR AND ASSOCIATED INFRASTRUCTURE

SPECIFICATION SL: SOFT LANDSCAPE

DETAILED SPECIFICATION DOCUMENT
REV 01

OCTOBER 2024

[redacted]

LANDSCAPE SPECIFICATIONS

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A. PRELIMINARIES

1.0 DESCRIPTION OF WORK

1.1 SCOPE OF WORK

The contract encompasses the furnishing of all materials, labour, services equipment a n d plants needed to complete the works as specified in the whole of the contract, according to approved horticultural practice, at the Muldersvlei Reservoir. The contract is to be implemented as indicated on the drawings. Information on the scope of these works is set out separately in the Bills of Quantities. The Contractor will be required to enter into a contract with the Client and will be responsible for the following:

a) Soil preparation

The supply and mixing of imported compost and topsoil products and insitu topsoil.
The placement and grading of the planting mixture in planting beds, raised planters and tree pits.

b) Planting

The supply and planting of trees, shrubs, bulbs, and groundcovers across the site and detention pond.
The mulching of these planted areas.

c) Tree stakes and supports

The installation of tree stakes and supports as detailed.

d) Maintenance

Each completed section of the contract must be maintained up until the issue of a Practical Completion Certificate. From that date, a further maintenance period of twelve (12) calendar months shall commence, at the end of which and following a final inspection, a Certificate of Final Completion shall be issued to the Contractor.

[redacted]

1.2 DRAWINGS

1001757-2000-DRG-CC-2395	LANDSCAPE DESIGN LAYOUT PLAN - ADMIN BLOCK
1001757-2000-DRG-CC-2396	LANDSCAPE DESIGN LAYOUT PLAN - GAURDHOUSE

2.0

a) The tenderer must allow for changes in the timing and sequence of other on-going contracts on site. While every attempt will be made to keep all parties informed of actual construction programmes, due allowance must be made in the construction programme and in the tendered price for changes in the overall sequence of operations.

3.0 MATERIAL AND WORKMANSHIP

3.1 ORDERING OF MATERIALS

a) The Contractor shall place orders timeously for materials, trees, shrubs, plants,etc. that are required. Should the Bill of Quantities be used for ordering materials, this shall be entirely at the Contractor's risk.

3.2 SAMPLES OF MATERIALS AND WORKMANSHIP

a) The Contractor shall furnish, at his cost, such samples of materials, workmanship and specimens of plant material as may be called for by the Landscape Architect / Client for his approval and who may reject all material, workmanship, etc. not corresponding to samples.

[redacted]

B. PREAMBLES

1 GENERAL

a) This Specification is supplementary to any issued drawings. Where discrepancies exist between the specification and the drawings, the specification is to generally take preference, but the Landscape Architect is to be informed immediately to clarify the position.

b) Each work phase described herein shall be approved by the Landscape Architect before the placement of any material.

1.1 QUALIFICATIONS

a) The Contractor must be a registered member of SALI (South African Landscapers Institute). All work shall be executed by experienced personnel under the direction of a skilled foreman.
b) Planting works to be executed under the supervision of a qualified and experienced horticulturalist.

2 PREPARATION

2.1 EXCAVATION

a) Excavation and cultivation of planting areas will be done in accordance with information set out in the bill of quantities.

2.2 RIPPING/ CULTIVATING

a) The Contractor is to provide a methodology of this activity for approval prior to commencement. The Contractor is to comply with all health and safety requirements.

b) Ripping to the specified depth shall be done in landscaped areas where required or instructed by the Landscape Architect.

c) As per the General details, the Contractor is to ensure that the underground services are clearly marked before commencing the ripping. Any damages will be for the Contractors account.

d) Ripping shall include the breaking up of hard earth and the removal of large boulders and rocks >80mm Ø. Ploughing and ripping shall not be carried out within the branch spread of trees, unless the Landscape Architect otherwise issues instructions.

e) The Contractor is to collect all rock of boulders >80mm Ø and locate on site as directed by the Landscape Architect.

2.3 SITE CLEANING

a) Site cleaning shall be done on a continuous basis, and the Contractor is responsible to remove the material from site and dump at a registered dump site.

b) All plastics, paper, metals etc that are imported as a result of the landscape works is to be removed immediately.

c) Rock that is generated from excavations or clearing of the site is to be stockpiled, measured and removed from site, or alternatively packed on site as directed by the Landscape Architect.

[redacted]

d) On completion, all surplus materials, waste, etc shall be loaded and removed and every part of the work is to be left in a sound condition, free from any defects whatsoever, and to the entire satisfaction of the Landscape Architect.

3 MATERIALS – PLANTING MIXTURE

3.1 TOPSOIL

a) Imported topsoil will be used in this project. A sample of the top soil that the Contractor proposes to use must be submitted to the Landscape Architect for approval.

b) Imported topsoil must be sand-clay-loam with an ideal composition of 15-25% clay, 10% silt, 60-75% sand. The minimum organic material must be 10% and the topsoil must be free from harmful salts, substances and seeds. The pH shall be between 5.5 and 6.5. Imported topsoil to be from a source, pre-approved by the Landscape Architect.

3.2 COMPOST

a) A sample of the compost that the Contractor proposes to use must be submitted to the Landscape Architect for approval. The source of the compost supplier must be revealed and under no circumstances may the Contractor change his source without the written approval of the Landscape Architect.

b) The following quality standards in Table 1 are not compulsory, but the Contractor must source compost with similar specifications as far as possible:

Table 1:

Indicator	Quality Standard for Finished Compost
Visual	All material is dark brown (black indicates possible burning).
	Parent material is no longer visible.
	Structure is mixture of fine and medium size particle and humus crumbs.
Physical	Moisture: 30-40%,
	Fine Texture (all below <20mm)
	Stones % of dry weight < 5% of >5mm size
	Reduction of organic matter must be > 60 percent by weight.
Salts	EC measurement (3 - 6 dS/m)
Odor	Smells like rich humus from the forest floor; no ammonia or anaerobic odor.
Curing period	21 days in a state conducive to aerobic biological activities
Temperature	Compost will not reheat upon standing to greater than 20°C above ambient temperature or the compost no longer reheats to thermophilic temperatures.
Foreign matter	Compost must not contain any sharp foreign matter measuring over a 3 mm dimension that may cause damage or injury to humans, animals and plants during or resulting from its intended use.
	Any matter over a 20 mm dimension that results from human intervention and having organic or inorganic constituents such as metal, glass and synthetic polymers (e.g. plastic and rubber) that may be present in the compost but excluding mineral soils, woody material and rocks."

[redacted]

Nutrient	max 0.5% >2mm Carbon:Nitrogen Ratio	<17:1
	Total Organic Matter	20-35%
	Total Nitrogen	1.0-2.0%
	Nitrate Nitrogen	250-350 PPM
	Nitrite Nitrogen	0 PPM
	Sulfide	0 PPM
	Ammonium	0 or trace
	pH	6.5-8.5
	Cation Exchange Capacity (CEC)	>60 meq/100g
	Humic Acid Content	5-15%
	ERGS Reading	5,000-15,000 mS/cm
Microbiological	Heterotrophic Plate Count	$1 \times 10^8 - 1 \times 10^{10}$ CFU/gdw
	Anaerobic Plate Count	Aerobes: Anaerobes at 10:1 or greater
	Yeasts and Molds	$1 \times 10^3 - 1 \times 10^5$ CFU/gdw
	Actinomycetes	$1 \times 10^6 - 1 \times 10^8$ CFU/gdw
	Pseudomonads	$1 \times 10^3 - 1 \times 10^6$ CFU/gdw
	Nitrogen-Fixing Bacteria	$1 \times 10^3 - 1 \times 10^6$ CFU/gdw
	Compost Maturity	>50% on Maturity Index at dilution rate appropriate for compost application.
	Compost Stability	<100 mg O^2/Kg compost dry solids-hour
Trace Elements maximum concentrations - mg/kg (air dried mass)	Arsenic (As)	13
	Cadmium (Cd)	3
	Cobalt (Co)	34
	Chromium (Cr)	210
	Copper (Cu)	100
	Mercury (Hg)	0.8
	Molybdenum (Mo)	5
	Nickel (Ni)	62
	Lead (Pb)	150
	Selenium (Se)	2
	Zinc (Zn)	500
	Boron	100
	Magnesium	No value
	Iron	No value
Pathogens	E. coli	< 3 E. coli/g
	Fecal Coliforms	<1000 MPN/g of dry solids
	Salmonella	< 3 MPN/4g total solids

[redacted]

End-Use Test Values for Compost		
	Salt	< 2.5 g/liter
	Avail-N	< 800 mg/l
	Phosphate	< 800 mg/l
	Potassium	<1,500 mg/l
	Maturity	Dewar V , pass plant test or Solvita 7-8
	Organic Matter%	> 30
	pH declared	5.5 - 7.0
	Foreign Matter	max 0.5% >2mm

3.3 FERTILISER

a) Only organic fertilizers are to be used.

b) All fertilizers are to be mixed into the growing medium when preparing the soil, at specified rates:
   - 1kg/m3 for tree holes,
   - 0.25kg/m3 for planting areas,
   - 0.1kg/m3 for lawn areas,
   - Or in accordance with supplier specifications.

c) After planting, additional approved organic fertiliser is to be spread over the ground at 250g/m2.

d) Bone meal is to be dusted onto the rootballs of all plants before placing in the planting holes at 0.250kg/m3 of soil or as per supplier's specifications.

e) Where soil tests reveal nutrient deficiencies, supplementary fertilisers are to be added to the approval of the Landscape Architect.

f) Fertiliser shall be supplied by an approved manufacturer and applied as per manufacturers' instructions and to the satisfaction of the Landscape Architect. Commercial fertiliser shall be complete, uniform in composition, dry and free-flowing. The fertiliser shall be delivered to site in the original unopened container, each bearing the manufacturer's guarante. The fertiliser must be well mixed into the planting mixture prior to planting.

3.4 MULCH

a) All planted areas as directed by the landscape architect shall receive well decomposed, course mulch once the bed is planted up and repeated during maintenance as specified. A mulch sample is to be approved by the Landscape Architect.

3.5 GENERAL

a) Samples of all mixes are to be approved by the Landscape Architect before delivery to the site.

[redacted]

4 VOLUMES OF EXCAVATION, FILLING AND COMPOST

a) The volumes of excavation, filling, compost, etc. are the net, compacted, in-situ quantities. Prices for excavation, filling, compost, etc. are to allow for the additional volume required due to bulking and for the consequent additional handling and carting involved as no allowance has been made in the measurement for same.

5 PLACING OF PLANTING MIXTURE

a) The planting mixture (imported topsoil and compost) to be mixed prior to delivery of mixture to planting areas (only where applicable). This is to take place at designated location as agreed upon by the Landscape Architect and Main Contractor.

b) The planting mixture shall be backfilled into shrub/ tree pits in 100mm layers and each layer shall be firmly tamped in place.

c) All excavations, after shaping, are to be backfilled to original grade.

d) Shrub and groundcover areas to receive a minimum of either 300mm planting mixture or as otherwise indicated by the Landscape Architect.

6 PLANTING

6.1 SCOPE OF PLANTING

a) Scope of planting shall mean trees and plants required to be furnished for the project in accordance with plans and as specified herein.

b) All plant material will be inspected and approved by the Landscape Architect. Plant names indicated on plans must conform to the standard nursery and/or botanical nomenclature and prevailing revisions of the time.

c) Substitutions will not be permitted without the prior agreement of the Landscape Architect. If proof is submitted that specific plants or sizes are unobtainable, proposals will be considered for the nearest equivalent size or variety with equitable adjustments of contract rates.

6.2 PLANT SUPPLIES

a) All plant material supplied by the Contractor shall be true to species and variety.

b) All plant material, unless otherwise approved by the Landscape Architect, must be nursery-grown in accordance with good horticultural practice.

c) Each tenderer shall investigate the sources of supply and be certain that he can supply all of the plants named in the plant list in the size, variety and quality required before submitting his tender. Failure to take this precaution will not relieve the successful tenderer from his responsibility as contractor for furnishing all the plant material in accordance with the contract requirements and without additional expense to the Employer.

[redacted]

d) Seedlings in 98, 128 & 200 plug trays to have visible strong root growth from underneath the tray and should be a minimum of 150mm in length. Over grown seedling trays result in g in lanky bare plants will not be accepted.

e) Seedlings in 98, plug trays shall be grown in a planting medium volume of not less than 100ml.

f) The use of collected plants will not be permitted unless specified by the Landscape Architect.

g) All plant materials shall be selected and tagged with proper identification prior to delivery to site.

h) Plants should be true to type (species, genus and variety) and structurally sound, well-branched, healthy and vigorous and free of disease, insect infestations, rodent da ma g e, sun-scald and other abrasions or scars to the bark. They must be densely foliated when in leaf and have a healthy, well developed root system. Pruning wounds should show vigorous bark on all edges and all parts shall be moist and show live, green cambium tissue when cut.

i) Plants shall not be pruned prior to delivery. All trees will be straight stemmed and of equal size/ height for each genus and species. No stunted, dwarfed, malformed or trees with crooked stems will be accepted.

j) All plant materials shall conform to the measurements specified in the schedule except that plants larger than specified may be used if approved by the Landscape Architect. The u se of such plants shall not increase the contract price. If larger plants are used, the ball of earth excavated shall be increased in proportion to the size of the plant.

k) All plants shall be measured when the branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant not from branch tip to root base or from branch tip to branch tip.

l) Specimens lacking compactness or proper proportions, which are weak or thin, or injured by too close planting in nursery rows will not be accepted.

m) Tree species are indicated on the planting plans and must be strictly adhered to. Tree size specifications are as follows or to general horticultural standards:

Bag Size	Name	Height	Canopy	Stem
250ℓ	Kiggelaria africana	3m	1.25m	5-6cm
250ℓ	Brachylaena discolor	3m	1.25m	5-6cm
250ℓ	Erythryna caffra	3m	1.25m	5-6cm

6.3 INSPECTION

a) Plant materials supplied by the Contractor, shall be subject to inspection and approval at place of growth and/or upon delivery for conformity to specification requirements as to quality, size and variety.

b) Plants in 4L bags shall have been established for at least 6 months and 50L and larger for at least 12 months in their containers.

c) The Contractor will give timely notice in writing to the Landscape Architect when such materials are available for inspection.

[redacted]

6.4 GUARANTEE AND REPLACEMENTS

a) All bought plant materials shall be guaranteed by the Contractor for the period of construction until Final Completion/ handover to the Client.

b) During the guarantee period, all plant materials found dead or not in a healthy, satisfacto ry growing condition or which, in any other way does not meet with the requirements of the specifications, shall be replaced without delay by the Contractor at his own expense.

c) All required replacements shall be with plants of the same size and species as specified and shall be supplied and planted in accordance with the drawings and specifications.

7 PLANT PURCHASE

a) Plant material shall be purchased and / or secured by the Contractor at the earliest, to ensure availability and for acclimatising of plants. Payment for plants purchased and held off-site or in the holding nursery may be claimed for but would be subject to the Contractor providing a bank surety to the value of such material.

b) The Contractor shall allow for the holding and maintenance of p re -purchased plants at his cost.

8 HANDLING OF PLANTS

a) All plants must be well protected against damage and drying out from the time of acceptance and until they are planted on the site.

b) Promptly after arrival of the trees, water them well and spray each tree with a solution of Wilt-Pruf or similar approved (One-part Wilt-Pruf to 10 parts water) or similar approved. Spray the solution to the point of run-off, both on the upper and lower side of the leaves. This operation is to be carried out in the morning of a sunny day, so that the trees can standat least 5 hours without rain washing the leaves off.

c) No roots may be cut or pruned without the written permission of the Landscape A rch it e ct . No roots may be split or torn. Should pruning be necessary, the rootball must be cut at th e edge of the ball with clean, sterilised and sharp tools. A 1:10 solution of Sodium Hypochlorite (Jik) can be used to sterilise tools prior to use.

d) Plants shall be transported with care taken to prevent damage. Branches shall be carefully ties in such a manner so as not to break or damage trunks. Points of contact with equipment shall be padded.

e) Rootballs, trunks, branches and leaves shall be protected from sun and wind desiccation.

9 POSITIONING OF PLANTS

a) All tree positions must be pegged out on site for the Landscape Architect's approval prior to preparation and planting. Tree species are indicated on the planting p lans and must be strictly adhered to.

b) Shrub and groundcover areas are indicated on the planting plans. Setting out is to be approved by the Landscape Architect, on site, before planting takes place.

[redacted]

10 PLANT INSTALLATION

a) Planting must be done during suitable periods with respect to weather conditions and locally accepted practice.

b) Plants must be set plumb in the centre of the pits and at the same relation to grade as originally grown, after settlement has taken place.

c) Trees and other plant materials must be faced to give the best appearance or relat ionship to adjacent structures to the approval of the Landscape Architects.

d) Shrubs, groundcovers and climbers must be planted at the rate indicated on the drawings.

e) Any plastic or metal containers must be removed completely without damaging the rootball. Metal containers must be cut for plant removal. All shrubs and small trees must be handled by the rootball and not by the plant stem. Soil mixture must be backfilled in 100mm la ye rs and each layer must be firmly tamped in place in such a manner that the pla n t reta in s its vertical position.

f) Particular care shall be taken to ensure that air pockets remain under or around the ro o t s. Running water can be used to dispel pockets of air at the time of planting and during backfilling.

g) All trees and irrigation pipes must be protected from damage during all phases of work.

11 PLANTING OF PLANT MATERIAL

11.1 PREPARATION

Trees:

a) Excavate a hole in the growing medium big enough to take the rootball of the nursery-grown tree. Remove the plant from its container and plant it in a planting medium as previously described. Top of soil ball to be level with finished ground level. Form a basin 1,9m in diameter x 150mm deep around tree where applicable and water with hand-held hose directly after planting. Trees must be sprayed with 'Wilt-Pruf' again in their final planted position 25 days after them being planted and not more than 45 days after their first application. (Refer to HANDLING OF PLANTS).

Shrubs and Groundcovers:

b) Excavate a hole to suit rootball size of plant, remove plant container and plant shrubs in hole in pre-prepared planting medium as previously described. Top of soil ball to settle level with the finished grades.

c) All plants planted in their final position must be watered with an approved soil wetter, no longer than 2 days after them having been planted. This procedure must be repea ted no longer than 6 weeks later or on the Landscape Architects' instructions.

12 PRUNING

[redacted]

a) All plants shall be pruned at a time designated by and to the satisfaction of the Landscap e Architect. The amount of pruning shall be limited to the minimum necessary to remove dead or injured branches and to compensate for the loss of roots as a result of transplanting operations. Generally, a maximum of 1/3 of the wood of deciduous plan ts can be removed by thinning or shortening of branches. Pruning shall be done in such a manner as to preserve the natural character of the plants. Leaders shall not be removed. Only clean, sharp tools shall be used.

b) All cuts shall be clean and flush, leaving no stubs. Cuts, bruises or scars on the bark sh a ll be traced back to living tissue and removed. The affected areas shall be shaped so as not to retain water and all cuts exceeding 15mm shall be painted with an approved tree wound sealer, immediately after having been cut.

c) The Landscape Architect shall inspect all pruning within normal inspections and shall request additional pruning to be done if it is found to be unsatisfactory.

13 WATERING

a) The Contractor will be required to water all plants and trees adequately and as often as necessary during the duration of and up to completion of each portion, to ensure proper growth and to keep the soil moisture content in the top 300mm between field capacity and wilting point. Watering must be to the satisfaction of the Landscape Architect and adjustments must be made accordingly.

b) A hand-held hose with a fine rose is to be used on a daily basis, until the completed area can be irrigated by way of an automatic irrigation system. All areas of ground cover, shall also, on a daily basis, be hand-watered in addition to receiving water via drip-irrigation, for the first four (4) weeks after planting.

14 MAINTENANCE

14.1 SCOPE OF MAINTENANCE WORK

a) A Certificate of Practical Completion as well as a Final Completion list will be issued. All items listed requiring attention must be rectified within the twenty (20) working day contract period.

b) Maintenance shall consist of watering, weeding, mowing, fertilising, disease and insect/pest-control, pruning, aerating, protective spraying, replacement of unacceptable material and any other procedure consistent with good horticultural practice necessa ry to ensure normal, vigorous and healthy growth of the plant material on site.

c) Maintenance personnel with a trained foreman shall visit the site on a weekly basis. A proposed maintenance schedule for twelve (12) months shall be submitted to the Landscape Architect for approval. Prior to any maintenance work commencing, all defects that may become apparent during this period shall be thoroughly investigated and rectifie dby the Contractor to the Landscape Architect's satisfaction.

d) The Contractor shall be responsible for the use of all materials, labour and equipment and any injury to plant material caused by such material, labour and equipmen tshall be corrected and repaired by the Contractor at no additional expense to the Client.

e) Allowance must be made for safety equipment and inductions of all maintenance staff accessing the roof gardens.

f) The maintenance period shall be for a minimum period of twelve (12) calendar months, but

[redacted]

may be negotiated at the request of the Landscape Architect and/or Client.

g) The Landscape Architect shall inspect all work within normal inspections and shall request additional work when regarded necessary. Payment for these shall be done accord in g to individual priced items or day works.

h) The Contractor will be required to submit a written report on a monthly basis or by the 20th of every month. The report is to outline the extent of all the work done and all the materials used during that month. A programme outlining the work, dates and materials anticipated to be used in the following month must also be included in this report. The report must be accompanied by the claim submitted for that month. (Refer to REPORTING).

14.2 WATERING

a) The irrigation system installed on the site must be used by the Landscape Contractor forthe watering programme, but any failure of this system does not eliminate the Contractor's responsibility of maintaining the desired level of moisture necessary to maintain vigorous, healthy growth.

b) Provision should be made in the costing, if the irrigation system fails, to irrigate all landscaped areas by hand-held hose.

c) The quantity of water applied at any one time shall be sufficient to penetrate the soil to an optimum depth of 300mm and at a rate which will prevent saturation of the soil.

d) Submit a schedule of the watering programme for approval and adjust the approved schedule to fit requirements necessitated by changes in weather conditions and climatic factors.

14.3 WEEDING

Shrub and groundcover areas and tree surrounds:

a) Remove all weeds manually, making sure to remove the roots also.

Dumping of weeds:

b) Do not stockpile weeds, but place directly in a refuse bag and remove from the site and dump at an approved compost dumping site.

Chemical control:

c) No herbicides may be used without prior written permission of the Landscape Architect, o r on the Landscape Architect's request. If used, it must be mixed and applied strictly according to manufacturers' instructions and must be overseen by a qualified person. Onlyequipment designed for the purpose may be used with the necessary protective clothing provided for the application team.

d) A neatly made signboard to the Landscape Architect's approval must be erected in a visible place near or at the area being sprayed, warning the public and personnel of the application of poison. This board must stay up for the entire active residue period, i.e. 7 days or 14 days, as indicated on the manufacturers' instructions.

14.4 FERTILISING

a) All fertiliser to be organic, e.g. Neutrog or similar approved

b) Apply all organic fertiliser as per manufacturer's specifications in quantities and at recommended periods throughout maintenance.

c) Irrigate the lawn well directly after the application of fertiliser.

[redacted]

14.5 MULCH

a) All planted areas as directed by the landscape architect shall receive well-decomposed course mulch. Supply and place coarse bark mulch (screened to 50mm) to all shrub planting areas to 50mm thickness (Area= 305m²) every 3 months. A mulch sample is to be approved by the Landscape Architect

14.6 DISEASE AND PEST CONTROL

a) Inspect all plant materials on a weekly basis during normal site visits to locate any disea se or insect pest infestations. Upon the discovery of any disease or insect pest infestation, identify, or have identified the nature of species of the infestation and submit the proposed method of control to the Landscape Architect for approval, prior to applica tio n o f co n tro l measure.

b) Pest control shall be managed on a prevention basis. As such, harmless measure s mu st be taken insofar possible before using pesticides/ fungicides.

14.7 PRUNING

a) Keep all plant material free from dead wood, broken branches, dead flower heads or otherwise harmful objectionable branches or twigs. All other pruning shall be done only a s directed by the Landscape Architect. All pruning wounds greater than 12mm diameter shall be painted with an approved tree wound sealant, such as Steri Seal. Only sharp tools, designed for pruning, shall be used, i.e. secateurs and/or loppers.

14.8 REPLANTING

a) Plants and shrubs which die or become unhealthy from any cause or appear to be in a badly impaired condition, shall be removed promptly and replaced as soon as weather permits, as directed by the Landscape Architect. All replacements shall be plants of the same kind and quality as the plant to be replaced. All groundcover areas shall have planting at the specified spacing at the beginning and an acceptable cover at the end of themaintenance period, i.e. not less than 75% of the planted area shall be covered.

14.9 ACCESSORIES

b) Maintain all stakes in good condition. This includes ensuring that tree guys remain taut and the replacement of all such accessories when required. Where the tree guys or stakes damage the trees, this will be rectified immediately at no further cost to the Employer.

14.10 LITTER AND REFUSE

a) During maintenance, remove all litter from the planting beds/ raised planters.

b) Collect and remove all garden refuse and do not leave small piles lying around. Place waste directly in a refuse bag and remove from the site to an approved dump.

c) Do not leave machinery or equipment unattended at any time.

14.11 MAINTENANCE STAFF

a) The Contractor will be required to have access to the landscaped areas for regular maintenance.

b) The maintenance contractor will be subjected to the following security arrangements andhis

[redacted]

compliance thereto will be of the utmost importance. Failure to abide by the se cu rit y arrangements will be a serious offence and may result in the cancellation of the maintenance contract and forfeiture of any retention still held.

c) The process to be followed is as follows:

d) All maintenance teams must be under the direction of a suitably qualified responsible person.

e) All maintenance personnel must wear company-issued overalls so that they can be immediately identified.

f) All maintenance personnel must wear company identification tags with name and photograph.

g) Company vehicles will be directed to park in designated parking areas near the site. If heavy deliveries are made, the vehicle is to drop off its load at a point as near to the a re aof final destination as possible and return immediately to the designated parking area.

h) All personnel and vehicles will be 'signed in' at either of the entrances and will be 'signed out' at the end of the day or when they leave.

i) Personnel will be restricted to the landscaped area only and are to consider all other areas, OUT OF BOUNDS.

j) All garden refuse is to be neatly bagged and removed off-site the same day.

15 COMPLETION

a) On completion, all surplus materials, waste, etc. shall be loaded and removed and every part of the work is to be left in a sound condition, free from any defects whatsoever, and to the entire satisfaction of the Landscape Architect.

16 MEASUREMENT AND PAYMENT

a) Separate items shall be schedules for the soft landscaping works. The items shall be measured in the unit scheduled. The sum or rate for such item shall cover the cost of all Materials, labour and plant required to execute and complete the work as specified in this specification, described in the Bill of Quantities and as shown on the drawing(s).

[redacted]

SPECIFICATION: SPE-FI-0001

WET FIRE PROTECTION

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1. FIRE SAFETY AND PROTECTION SPECIFICATION

1.1 GENERAL

The particular specifications included in this document define the systems, materials, and equipment to be used for the fire services installation.

This Standard Specification shall be read in conjunction with the Bills of Quantities, if any, the Detailed Specification and Drawings, in which the exact extent of the work will be identified. All rules, regulations, by-laws, codes, and standards as specified in the technical specifications shall apply unless otherwise specified in the particular specification.

The building is to be equipped and protected by means of a conventional fire protection installation designed, supplied, installed, tested, and commissioned in accordance with the relevant SANS Standard requirements and the requirements of the Local Authority having Jurisdiction.

1.2 DESCRIPTION OF THE WORK

The works required by the fire contractor shall be to supply and install wet fire protection and regulatory signage items included but are not limited to; hydrants, hose reels, fire extinguishers, regulatory fire signage and fire pumps as itemized in this specification and BOQ provided.

1.3 CONFIDENTIALITY

All drawings, memoranda, ideas, and information supplied for the works shall remain the property of the party so supplying such drawings, memoranda, ideas, and information on the express understanding that they will be treated as private and confidential and not be used in any way, except in connection with the single installation for which they are intended.

No details of any drawings, memoranda, ideas, and information shall be published or disclosed in any trade or technical paper or elsewhere without the previous consent in writing of the party that supplied such drawings, memoranda, ideas and information.

1.4 COMPLIANCE WITH REGULATIONS

The works shall comply with all the requirements and bylaws of the relevant local authorities. Where the proposed layouts, or any of the materials specified, etc., do not comply with the regulations, the matter shall immediately be brought to the attention of the Engineer in writing.

The complete works shall comply in particular with the specifications and requirements of:

- SANS 10400, Section T and Section W Fire Protection and Fire Installation, as amended.
- The Occupational Health and Safety Act, Act 85 of 1993, as amended.
- SANS 1128, Part 1:2010, Components of underground and above-ground hydrant systems, as amended.
- SANS 543:2004, Fire hose reels (with semi-rigid hose).
- SANS 1567, Hydrant Installation
- SANS 1910 - Portable Fire Extinguishers

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- SANS 10252. Part 1:2004, Water Supply Installation for Buildings, as amended.
- This detailed specification and the Engineer's drawings forming part of the tender documents.

Certificates of approval/inspection from the local authority shall, if called for, be submitted to the Engineer before the final payment certificate will be issued.

The above shall take preference over all other specifications and requirements. However, any deviation from this specification shall immediately be reported to the Engineer.

The works shall furthermore comply with all the requirements and bylaws of the relevant local authority. Where the proposed layouts, or any of the materials specified, etc., do not comply with these regulations, the matter shall immediately be brought to the attention of the Engineer.

The Subcontractor shall furthermore issue all notices and pay all fees required to be given or paid in terms of statutory and regulatory requirements and the relevant local authority's bylaws.

1.5 DEVIATIONS FROM STANDARD SPECIFICATION

The quality of workmanship, materials to be used, equipment etc, shall be as specified in these documents. Where discrepancies exist between the Bills of Quantities, the Standard Specification and the Detailed Specification, the Detailed Specification shall have preference over both the Bills of Quantities and Standard Specification. The Standard Specification shall furthermore have preference over the Bills of Quantities.

Any discrepancies found between the Bills of Quantities, Standard and Detailed Specifications shall be brought to the attention of the Quantity Surveyor and Engineer in writing within seven (7) days of its discovery.

1.6 MAKE OF EQUIPMENT

Similar items of equipment used throughout this contract shall be of the same make and, where applicable, of the same model.

1.7 MATERIALS, WORKMANSHIP AND ALTERNATIVE MANUFACTURE

All materials shall be of the qualities specified and the subcontractor shall, upon request by the engineer, furnish the engineer with proof to his reasonable satisfaction that the materials are of the specified quality.

The subcontractor shall keep the engineer informed regarding the placing of all orders for materials and the progress of manufacture or any article or materials.

All materials shall be new unless otherwise instructed or specified.

Materials, goods, and equipment described by trade names or catalogue references shall be of the type and manufacture specified. Alternative materials, goods, and equipment equal to those specified may be offered. The decision whether the alternative articles are acceptable shall rest with the engineer.

Where alternatives for such materials, goods and equipment are permitted, the subcontractor shall be liable for latent defects in such materials, goods, and equipment and or the cost of making good physical loss and repairing damage to the works resulting therefrom.

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Once accepted, the same type and make of material, goods and/or equipment shall be used and installed throughout the project for a specific application.

1.8 PROTECTION

The subcontractor shall protect all work and material, i.e. his and others, from damage by his work and workmen, and shall be liable for all damage caused should the protection not be provided or prove to be inadequate. The subcontractor's responsibility in this respect shall extend until his work and equipment have been finally inspected, tested and accepted.

Open ends of pipework shall be closed with temporary covers or plugs during storage and construction to prevent entry of obstructing material. This shall be strictly enforced.

1.9 COMMISSIONING

Comprehensive pre-commissioning, commissioning as well as quality monitoring and checking will be done on all the Fire protection Services systems, Conventional Fire system, and fire services controls, installations in accordance with the relevant SANS Commissioning Codes.

The commissioning report shall be submitted which must:

- Demonstrate that the services were commissioned in compliance with the relevant SANS Commissioning Codes.
- Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues.
- Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all the recommendations; and
- Reference appended extracts of commissioning records for major plant and equipment as deemed appropriate by the relevant project team members involved in the commissioning process and as referenced in the commissioning report.

Commissioning shall be meticulous, and all procedures as stipulated by the suppliers of the equipment shall be strictly adhered to.

The Subcontractor shall prepare detailed commissioning schedules well in advance of the programmed practical completion inspection date.

The schedules shall make allowance for all measurements that will be required, checking of operational and safety set-points, test results, etc., and shall be submitted to the Engineer for approval prior to the start of commissioning.

The Subcontractor shall submit the completed schedules to the Engineer for checking after commissioning has been completed, and prior to the completion inspection.
Each task in these schedules shall be countersigned by the Subcontractor's Commissioning Engineer to ensure that any discrepancies between site and commissioning conditions/data can be clarified.

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The minimum commissioning requirements are:

Initial visual check

- Correct models or equipment, specification of piping, types of valves, etc. provided.
- Equipment located in correct positions and parallel to building lines unless otherwise specified.
- All piping neatly arranged and cleaned.
- Shipping fasteners, clamps, etc. removed or released.
- Joints tight and correctly fitted.
- All fasteners in position and tight.
- Signage installed securely (NO adhesives/double sided tape allowed) and in correct orientation.
- Coil piping correct configuration. (Counter flow, IN-at-the-bottom, OUT-at-the- top, etc.).
- Existence of sufficient, and where applicable, correctly fitted bleed-off, vent valves, drains, etc., as specified. (Both at components and in pipework.)
- Soundness and alignment of general supports.
- Installation workmanship and finish.

Pre-commissioning checks

- These checks shall include, but not be limited to:
- General state of system
- Checks before pipe filling
- Process for system filling and venting, including pressure testing.
- Full system flushing and cleaning.
- General system checks.

1.10 TESTING AND INSPECTION

The subcontractor shall, at his own cost, make all necessary arrangements and provide all necessary facilities for testing and inspection of the installation by the local authorities concerned and other authorised interested parties. The subcontractor shall provide any instruments or equipment required for these tests. The execution of these tests shall be to the complete satisfaction of the inspecting authorities/parties.

1.11 GENERAL CONSTRUCTION AND INSTALLTION REQUIREMENTS

All equipment, component parts, fittings and materials supplied and/or installed, shall conform in respect of quality, manufacture, test and performance to the requirements of the applicable current SANS specifications and codes, except where otherwise specified or permitted with approval from the Engineer in writing.

All materials and workmanship, which may in the opinion of the Engineer, be inferior to that specified for the work, will be condemned. All condemned material and workmanship

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must be replaced or rectified as directed by the Engineer, to the satisfaction of the Engineer.

The Contractor shall submit a complete, detailed equipment and material list to be used to the Engineer for approval prior to placing orders or commencing installation.

All new equipment, materials and systems shall be installed in such a manner and positioned as to not impede on access routes, entrances, and other services. The Contractor shall co-ordinate these items taking into account other services and equipment.

All control equipment and serviceable items shall be installed in such a manner and positioned to be accessible and maintainable.

The Contractor shall ensure that all safety regulations and measures are applied and enforced for the full Contract period to ensure safety of the workforce, public and user.

All materials and equipment shall be carefully examined for defects and flaws prior to installation. All defective and/or flawed materials and equipment shall be replaced with new.

All pipe installations shall be neatly fitted and properly secured and bracketed. Any underground pipework shall be treated and prepared by the contractor.

During construction all pipe ends shall be kept plugged to prevent any ingress of dirt and foreign matter.

All piping shall be installed in such a manner as to allow for contraction and expansion.

1.12 EQUIPMENT AND DRAWING APROVAL

The contractor shall supply equipment data for approval. Should the contractor deviate from the Engineers drawings, they will need to provide a drawing for approval.

1.13 PAINTING

The complete hydrant and hose reel installations, including all alarms, pipes, fittings, hangers, valves, etc., shall be painted by the Subcontractor.

All grease, oil, rust, scale, etc., shall be removed from the works by the application of solvents and wire brushing. The works shall then be primed with a coat of high-quality zinc chromate primer and finished with two coats of high gloss enamel paint.

The primer coat shall be allowed to dry completely before applying two coats of gloss enamel paint. The finishing paint colour shall be No. A-11, Signal Red. The first coat shall be left to dry completely before the next coat is applied. The final coat of paint shall only be applied after the system has been tested and the ceilings have been painted.

1.14 GUARANTEE AND MAINTANCE

The subcontractor shall guarantee the works against defects for a period of one (1) year from date of completion.

The guarantee shall cover all defects to the works and shall provide for the replacement or repair of all components that become defective during the guarantee period. Consumable components are excluded from the guarantee.

Where component parts or equipment are supplied by the employer, the contractor or the agent or where the make is specified without an alternative, then the subcontractor shall be responsible for such component parts or equipment only to the extent that the

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subcontractor is able to assign to the employer the benefit of warranties by the supplier or manufacturer.

The works is to be operated and maintained in accordance with the Operating and Maintenance Manuals prepared by the subcontractor. Any damage to the works resulting from the employer's failure to comply with the procedures set out in these manuals will not be covered by the guarantee.

The sub-contractor shall provide free maintenance for a period of 1 (one) year following the hand over to the client. The maintenance shall include for all management, labour, lubricating materials, cleaning materials and transport.

The guarantee shall be given to the Principal Contractor. Where the guarantee period extends beyond the patent defects liability period of the Principal Building Agreement, the guarantee shall be ceded to the employer for the remainder of the period.

1.15 OPERATION AND MANTAINANCE MANUALS

The contractor, as part of completion requirements shall provide 3 bound hard copies of the operation and maintenance manuals as well as a full digital copy to the client.

The manuals shall be properly bound and titled. Each set shall consist of 4 sections. Each section shall have the following sub-sections:

Section 1 – Operation

1.1 Introduction: Short description of the complete system to familiarise laymen with the system lay-out and operation.

1.2 Detailed description: A detailed description of each system and its equipment, complete with schematic drawings. The purpose of this system is to explain the intended operation of each system and item of equipment to technical personnel. Detailed descriptions of the operation, set-points, adjustments, etc., are thus to be included.

Section 2 - Commissioning data

2.1 Schedules of data: Detailed schedules of commissioning data of all the systems shall be included in this section for future reference. These schedules shall include, amongst others, air flow rates, major equipment power draws, pressure drops, etc.

Section 3 – Maintenance

3.1 Schedules: This section shall contain detailed maintenance and service schedules for the complete installation.

3.2 Equipment details: This section shall contain manufacturers' brochures, spare parts lists, and terms of equipment.

3.3 List of suppliers: The list of suppliers (complete with addresses and telephone numbers) for each item of equipment shall be included in this section.

Section 4 – Drawings

4.1 As-built drawings: A complete set of as-built drawings shall be enclosed in this section.

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2. TECHNICAL SPECIFICATION FOR REGULATORY FIRE SIGNAGE

A full set of Fire Design drawings for the buildings as well as a Bill of Quantities forms part of this tender. The tenderer is to price for the installation of external and internal fire safety signage as specified on the drawings, in accordance with the relevant SANS10400 and SANS 1186-1&5 standards. Allowing for all costs associated with procurement, installation, fixing and any other items/functions that may be required to complete the installation.

All regulatory fire safety signage shell be of the photoluminescent type unless otherwise specified and shall be mechanically fixed in aluminium frame.

These items include but are not limited to:

- Identification Signs: For each fire hose reel, hydrant, and extinguisher arrangement, or independently located item.
- Escape Route Signs: At each discharge pint as well as strategic wayfinding.
- Identification Signs: For each valve and alarm device.

2.1 STATUTORY REQUIREMENTS

The tenderer shall price and ensure that the entire Regulatory fire safety signage installation is in full compliance with all the relevant statutory requirements.

The design as indicated on the tender drawings shall be checked by the Tenderers against the statutory requirements.

These amendments shall be indicated in red on the tender drawings, which are to be returned with the tender documents, and noted in a tender covering letter. The Tendered Subcontract Sum shall include the relevant costs, if any, for the above amendments.

2.2 MAINTENANCE

Comprehensive written reports including repairing of defects, covering all routine maintenance shall be issued to the Fire Engineer during the 12-months period after practical completion. Written reports of all callouts shall be issued to the Fire Engineer, including rectification work undertaken and the reasons for the call-out.

3. TECHNICAL SPECIFICATION FOR CONVENTIONAL FIRE PROTECTION

3.1 SCOPE

This standard specification covers the standards, materials, and code of practice for the supply and installation of conventional fire protection systems for the building services trade.

This specification shall form an integral part of the contract document and shall be read in conjunction with the schedule of quantities, drawings and additional and particular specifications compiled as part of this document.

This specification shall act as a guideline to the particular specification, where in conflict the particular specification shall take precedence.

The Contractor shall at all times adhere to this specification unless otherwise specified in the particular specification.

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3.2 DETAILED PUMP ROOM INVENTORY

For the Fire Hydrant Electric Driven Fire Water Pump the Contractor is to allow for:

- Electric motor, mechanical coupling, pump mounted on concrete filled with base frame for a capacity as specified in this specification and in accordance with SANS 10287 and as hydraulically calculated by the Contractor.
- Electrical panel to supply and control the electric driven pump, fully designed, supplied, tested, installed, and commissioned as described by SANS 10287 and this specification.
- Bench test certificate for electric driven pump by an approved testing authority as required.
- 1 off water pipe cooling circuit from water-to-water heat exchanger on electric driven pump engine to catchpit drain including all fittings, piping, sight glasses and bracketing.

For the Fire Hydrant Diesel Driven Fire Water Pump the Contractor is to allow for:

- Diesel engine with water-to-water heat exchanger, batteries, mechanical coupling, pump mounted on concrete filled steel frame base as specified in this specification and in accordance with SANS 10287 and as hydraulically calculated by the Contractor.
- Diesel tank with hand operated diesel pump, level indicator, fuel line, fuel filter mounted on a stand next to diesel driven pump with sufficient diesel storage for 8-hour operation of diesel pump under load, including full tank diesel as per specification.
- Electrical control panel for diesel driven pump including voltmeter, battery chargers, tachometer, emergency stop/start, controls, 12-volt operation from batteries, hour meters etc, fully design, supplied, tested, installed, and commissioned as per this specification.
- A full lagged exhaust pipe from diesel pump to high level smoke extraction.
- Bench test certificate for electric driven pump by an approved testing authority as required.
- 1 off water pipe cooling circuit from water-to-water heat exchanger on diesel driven pump engine to catchpit drain including all fittings, piping, sight glasses and bracketing.

Pump room roof sprinklers C/W main connections, ranges, (standard response) 141° exposed sprinkler brass incl. accessories, conventional, installed pendent and painting.

For the Fire Hydrant Electrical Driven Fire Water Jockey Pump the Contractor is to allow for:

- Electrical motor, vertical multi-stage centrifugal pump mounted on steel frame base for a capacity as specified in the specification and in accordance with SANS 10287 and as hydraulically calculated by the contractor.
- A 200-litre membrane pressure vessel complete with accessories for jockey pump pressure zone.

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- Electrical control panel to supply power and control the electrical driven jockey pumps, fully designed, supplied, tested, installed, and commissioned as described by SANS 10287 and this specification.

For Pressure switch arrangement the Contractor is to allow for:

- AutoStart switch starting arrangement (one for each pressure zone) including pressure switches piping, fittings, valves, bracketing and connection between delivery piping and starting arrangement, specification document and detailed drawings. For main pump room

Pump discharge test arrangement including orifice plates, gauges, valves and discharge pipe to catchpit drain as per detailed drawing.

For pump room accessories the Contractor is to allow for:

- Locking devices, such as pad locks, chains etc., Valves shall be locked in the operating position.

3.3 PRESSURE TESTING

All pipes shall be pressure tested before taken into use. The Engineer shall witness this pressure test.

The Contractor shall provide two pressure tests to the entire system. The first test shall consist of a compressed air test to a minimum pressure of 1000 kPa. The second pressure test shall consist of water test to a minimum pressure of 1600 kPa and shall only be performed once the complete system has been installed and inspected and approved by the Engineer. The water to be used for the water pressure test shall be sterilized. On completion and approval of the water pressure test the system shall be drained and flushed and only filled with approved water from the completed water supply system on approval from the Engineer.

For water tests completed sections of the pipe installation shall be filled with water after all outlets have been plugged, sealed, or closed. The section of pipe shall be hydraulically pressure tested by means of a suitable manually operated or mechanically driven pressure pump. A pressure of at least 1,5 times the working pressure of the class rating of pipes or fittings, with a minimum pressure of 1600 kPa shall be applied for a period of time specified in the specifications or as recommended by the manufacturers.

Tests should not be performed against closed valves.

Leakages that occur shall be measured and calculated and checked against the allowable losses.

For underground pipe installations if the completed section of pipe complies with all specifications and passes the tests and inspection, it could be approved and the Contractor may be instructed to backfill the open sections of trench at the joints and connections, where applicable. The Contractor shall then proceed to build all the valve chambers, inspection chambers, etc.

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3.4 FLUSHING OF FIRE WATER SYSTEMS

Before any pipeline is taken into use, it shall be flushed over its complete length and including the fittings. The pipe shall be filled with potable water or similar approved water sources. The pipeline shall be filled for flushing in such a manner that no air is trapped in the pipeline.

At least 14 days prior to the commencement of flushing the Contractor shall submit full details of the proposed method of flushing the pipeline to the Engineer for his approval.

The cost of water for filling the pipeline for flushing shall be borne by the Contractor.

The Contractor shall provide all necessary materials, tools, equipment and labour necessary to flushing the pipeline. After flushing the pipeline, the Contractor shall, at no extra cost, empty the pipeline and dispose of the water in a manner approved by the Engineer.

3.5 REQUIREMENTS FOR CONVENTIONAL FIRE PROTECTION INSTALLATION

All conventional fire protection installations shall adhere to the technical and particular specifications and shall include the following general requirements:

Piping shall conform to applicable SANS Standards. Reference to a Specification from recognized authorities to establish basis of quality shall mean current edition at date of Tender.

Routes of pipes in roof spaces are shown on the drawings as a guide only and the Contractor must ensure that no pipes are placed in positions impeding on access routes and entrances and other services.

All pipes are to be carefully examined for defects and flaws before installation and shall be neatly fitted.

The ends of all pipes are to be cleaned, free from burrs and rough edges and joined together tightly. An approved pipe joint compound may be sparingly used with best quality hemp. All surplus or exposed hemp is to be thoroughly cleaned off joints before the painting of pipes.

All vertical pipes must be securely fixed with brackets and supports of an approved type, securely fixed into the wall not more than 40mm from the wall. These fixings must be strictly adhered to.

Pipes installed in service ducts and ceiling voids are to be perfectly plumbed and to be secured by approved brackets securely fixed at distances not exceeding the specified distances and not more than 40mm away from the face of the walls or soffits. Pipes inside buildings and where specified shall be chased into walls, wrapped with building paper and properly secured and covered. Pipes must be free to move in the brackets.

Pipes passing through the walls and concrete floors are to be provided with suitable pipe sleeves extending 10mm beyond finished floor or wall surfaces. All pipe fixings and throughways shall be free to allow movement for expansion, and contraction. Any pipe fitting feeding a pipe, which is rigidly secured to a structural element, shall be securely anchored to prevent any stress developing between the fitting and the structural element.

Chromium or nickel-plated metal covering plates are to be provided and fixed securely to pipes passing through the ceilings and walls. This is not applicable for concrete floors and ceilings.

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Pipes passing through the ceilings or floors shall be offset from the wall to the front of the cornice with sufficient clearance to allow for the clear fixing of a ceiling plate. Pipes installed directly through the cornice will not be allowed. The same shall apply in multi-storey buildings where wall thicknesses vary.

All offsets shall be evenly and symmetrically set, the offsets are to be as high and as near the ceiling as possible.

Pipes shall be installed in such a manner as to allow for contraction and expansion.

Fire hydrants, hose reels and fire extinguishers shall be placed in position as indicated on drawings, provided that the relevant coverage distances and areas as required by the relevant codes and regulations shall be adhered to. The equipment to be placed in such a position that the approach to these units is not obstructed.

During construction all pipe ends shall be kept plugged to prevent any ingress of dirt, rubble, etc.NG

4. FIRE WATER PIPEWORK SPECIFICATION

4.1 BLACK MILD STEEL PIPE INSTALLTION

All steel pipes shall be medium gauge mild steel screwed and socketed pipes SANS 10400 Part W shall be normalized and marked as such by the manufacturer. Pipes shall be hot dipped galvanized.

All fittings shall be malleable cast iron fittings.

All Ø80mm and larger pipes shall be joined with Class 16 flanged couplings. The bolts, nuts and spring washers to be used on these joints shall be cadmium plated.

In pipe ducts and elsewhere pipes shall be fixed onto walls, soffits etc. with approved type of supports, holderbats, clamps, etc. Brackets shall be designed to structurally support and fix the pipe system and shall have sufficient clearance from walls, soffits, etc. to enable insulation of hot water pipes and maintaining of equipment.

Pipes shall be supported according to the manufacturer's specifications at the following maximum intervals:

PIPE SIZE (mm)	HORIZONTAL (mm)	VERTICAL (mm)
Ø15 to Ø20	1200	1830
Ø32 to Ø40	1830	2450
Ø50 to Ø150	2450	3050

Pipes shall be installed in such a manner as to prevent airlocks. A minimum rise of 1:250 shall be maintained to high points, which shall be fitted with suitable air release valves.

All pipes shall be marked according to the Local authority requirements or as specified by the Engineer. All surface pipes shall be painted to the required colour as specified by the Principal Agent.

Pipes shall be installed flush unless otherwise instructed by the Engineer.

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Provision shall be made for thermal contraction and expansion.

The type of pipe joint compound shall be approved by the Engineer and sparingly used with good quality hemp. For pipes larger than Ø80mm a jointing compound such as Epedermix 32 shall be used.

Any pipe buried shall have at least 900mm cover and be coated and wrapped and tested in the presence of the Engineer.

All pipework and fittings shall be pressure tested and sterilized to the Engineers specifications.

4.2 UPVC UNDERGROUND PIPE INSTALLATION

Unless otherwise specified all underground pipework > Ø50mm shall be Class 16 uPVC with rubber ring type joints.

All bends shall be uPVC Class 16 type fittings with rubber ring joints.

All other fittings such as T-pieces, Reducers, Flanges, etc. shall be bitumen dipped cast iron rubber ring jointed fittings.

No solvent weld type fittings will be allowed.

All cast iron fittings shall be coated and wrapped.

All pipes shall be laid on a 100mm sand-bedding cradle and covered with 300mm sand before backfilling.

All backfilling shall be to the Engineers specification and approval.

Pipe trenching and bedding:

AREA	MINIMUM COVER (mm)	BEDDING TYPE	MAIN FILL
Vehicle traffic	1100	Flexible pipe bedding	Soilcrete
Under surface bed	600		Soilcrete
Other areas	900		90 % MOD AASHTO

All thrust blocks shall be cast between the pipe and the undisturbed trench material.

No concrete shall come into direct contact with the uPVC pipe. At the thrust blocks the bend shall be wrapped with a "Densopol 80 HT Tape" or similar approved.

All pipes shall be laid with at least 900mm cover to the top of the pipe.

5. FIRE PROTECTION EQUIPMENT SPECIFICATIONS

5.1 VALVES FOR WATER INSTALLTIONS

Gate valves underground in valve chambers to connect to uPVC piping (65 NB and larger)

Gate valves to be equipped with non-rising spindle, spherical graphite iron body Grade 42, cast iron nitrile butadiene rubber covered gate, stainless steel spindle, nitrile butadiene

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rubber O-rings and seals, cast iron bonnet and gunmetal thrust collar to SANS 10400 Part W.

The valve shall be capable of withstanding a working pressure of 1600 kPa.

The valve shall be fitted with a square key spindle top to close the valve in a clockwise direction and socket ends to fit into uPVC Class 16 pipe and installed to detail.

5.2 NON-RETURN VALVES

Non-return valves for cold water (65 NB and larger)

The non-return valve shall be of the spring-loaded dual flap plate type fitted between two flanges. (Wafer)

The non-return valve shall be equipped with a cast iron body, aluminium bronze plates, stainless steel springs and neoprene seals on the plates. The valves shall be suitable for a working pressure of 1000 kPa.

Non return valves (up to Ø100)

The non-return valve shall be of the spring-loaded piston type, with bronze or dezincified brass body, stainless steel spring and bronze disc with neoprene seal fitted with BSP threaded socket ends. The valve shall be suitable for a working pressure of 1 000 kPa and a temperature of up to 90°C. All valves shall be installed as to be removable without extensive pipework removal.

Fire hydrants to be installed shall be of the type as approved by the local authority and shall be installed as indicated and detailed on the relevant drawings. The Hydrants shall comply with SANS 1567. The hydrants shall be installed inside purpose-manufactured cabinets as approved by the Architect and Local Authority. Hydrants shall be of the 65mm bore instantaneous female coupling type conforming to SANS with single-lug twist release. The valve shall be fitted with a blank cap fixed to a chain.

5.3 FIRE HYDRANT

Fire hydrants to be installed shall be of the type as approved by the local authority and shall be installed as indicated and detailed on the relevant drawings. The Hydrants shall comply with SANS 1567. The hydrants shall be installed inside purpose-manufactured cabinets as approved by the Architect and Local Authority. Hydrants shall be of the 65mm bore instantaneous female coupling type conforming to SANS with single-lug twist release. The valve shall be fitted with a blank cap fixed to a chain.

Where the supply pressure is higher than 5.2 bars a pressure-limiting device shall be installed inside the cabinet before the Hydrant.

5.4 TWIN BOOSTER CONNECTION

The fire booster connection shall be of the two-way breeching inlet type with end caps fixed to chains and shall comply with the local authority's requirements. The coupling shall comply with SANS and the inlet breeching piece shall comply with SANS. The booster connection shall be installed as indicated and detailed on the relevant drawings.

5.5 FIRE HOSE REEL

The fire hose reels shall be supplied and installed in accordance with SANS 543.

The hose reel shall be suitable for working pressures of up to 10 bars.

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The hose shall be of the 2 mm dia. (ID) rubber fire hose reinforced with double braiding and 30 meters in length. The hose reel shall be fully equipped with nozzle and stop cock.

The hand wheel shall be marked with an arrow and the words "OPEN" to indicate direction of opening.

The hose reel shall be securely fixed to the hose reel cabinet or structure if installed separately. The hose reel cabinet shall be of the 12 SWG steel cabinet fabricated type for surface mounted or recessed mounted. The cabinet is to be fitted with doors in accordance with the Architects and Local authority requirements. The cabinet shall be clearly marked "HOSE REEL".

Where the supply pressure is higher than 5.2 bars a pressure-limiting device shall be installed inside the cabinet before the Hose reel.

5.6 FIRE EXTINGUISHERS

Fire extinguishers shall be supplied and installed on a correctly sized and secured bracket as indicated and detailed on the drawings. The fire extinguisher shall be installed in accordance with SANS 1910, or other relevant SANS standard.

Fire Extinguishers shall be installed inside each fire cabinet and where elsewhere indicated on the drawings.

Fire extinguishers shall have the following capacity:

DCP (Dry Chemical Powder)	-	4.5 kg
DCP (Dry Chemical Powder)	-	9 kg
CO2 (Carbon Dioxide)	-	5 kg

5.7 LABELLING OF VALVES

All main stop valves, control valves, etc. shall be labelled by means of rust-free metal tags indicating their purpose and the section they isolate, if isolating valves.

The tags shall be securely fixed to the valve and shall be clearly legible.

All letters on labels shall be engraved or punched. No painted or plastic embossed labels will be accepted.

Alternatively, 12 mm wide stainless steel tape embossed labels, may be used, fixed with copper wire to the relevant valves.

5.8 COLOUR CODING OF PIPES

Identification of the contents of a pipeline shall be by means of applying a colour code on the specific pipe in the colours as specified by the Local Authorities.

Generally, the primary colour shall be applied to the entire length of pipework.

However, where short lengths of pipe run through occupied areas and in plant rooms, the primary colour shall be applied to their entire length.

5.9 LABELS

- Provide labels under each gauge, meter, instrument, indicating pilot lamp, and on each remote-control switch, motor controller and other equipment mounted on panels, indicating equipment controlled.

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- Labels: Screwed on, engraved black Ivorine sandwich sheet with white lettering. Inscription - as noted and approved.

5.10 VALVES TAGS AND CHART

- Provide all valves and controls with identifying number tag, including a letter to identify the system, fastened by heavy aluminium hook or chain.
- Tags: 50mm diameter 1,257mm aluminium with stamped numbers and letters filled in with black paint.
- Furnish diagrammatic charts showing essential features of each piping system, with all valves and controls lettered and numbered to correspond to designation on metal tags. Also furnish list of all valves and controls giving location and function.
- The above charts and lists shall be included in the maintenance manual as further detailed herein.

6. FIRE PUMPS INSTALLATION

6.1 GENERAL

Where required by the particulars of a specific fire protection installation, and as detailed in the Particular Specification and drawings, a fire pump set shall be installed. The pump set shall consist out of the number and type of pumps and ancillary equipment as detailed in the Particular specification. The following components shall form part of the installation:

- Electrical driven jockey pump set
- Electrical driven main fire pump and drive.
- Diesel driven main fire pump and drive.
- Fire pump starting arrangement.
- Electric and Engine drive controllers and ancillary equipment.
- Water flow test devices.
- Fuel storage and piping

Prior to ordering and installation, the Contractor shall provide a full set of plans and detailed data describing the following for approval by the Engineer and Local Authority:

- Pumps
- Pump drivers
- Drive controllers
- Power supply
- Starting arrangements
- Piping and fittings
- Suction and discharge connections
- Water supply and/or storage conditions

Each pump unit shall be provided with certified test curves by the manufacturer showing brake horsepower, flow, and head capacities. The Contractor shall provide this information to the Engineer and Local Authorities for approval.

The Contractor shall perform and certify a full field acceptance test on the completed installation. This test shall be witnessed by the Engineer and Local Authority.

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Reasonable tolerances shall be provided at all connections between joinery works and the building structure to compensate adequately for any irregularities, settlements, or any other movements.

6.2 FIRE JOCKEY PUMP

- The fire jockey pump installation shall consist of an electrical driven pump, installed with the necessary valves, strainers, non-return valves, pressure gauges, starting arrangement, drive controllers, etc.
- The pump shall be of the centrifugal multi-stage type, designed according to ASIB Twelfth edition and be completely equipped with an electric driven direct or close-coupled motor. The electrical drive shall be fitted with an approved drive controller fitted with the necessary safety features as allowed by ASIB Twelfth edition.
- The electric motor shall conform to BS 2613 and BS170 and be drip-proof. The windings must at least be according to IP 55 of IEC 144. High temperature, permanent sealed bearings shall be used.
- The rotation speed of the pump shall not exceed 2 950 revs/min, and the pump must be able to pump water with temperatures between 0°C and 45°C.
- Preference will be given to pumps of the self-regulating type and where the power consumption characteristic is such that with an increase in delivery to beyond a certain limit, the power consumption decreases, thereby ensuring that the motor is not overloaded in the event of a large reduction in pumping head.
- The pumps shall be manufactured according to the latest relevant rules and regulations of the local authorities and statutory bodies and be freely available on the market, including back-up service and parts.
- The design and fabrication of each pump unit shall allow for easy dismantling and removal of any serviceable part or piece of equipment, which functions as part of the pump units. The pump's serviceable parts or pieces of equipment shall allow for easy inspection. Parts, subjected to wear and tear, shall be replaceable and may not form an integral part of the body unit. The types and angle between suction and delivery points shall be suitable for this installation.
- All parts and pieces of equipment, which make up the pump units, shall be manufactured of suitable approved material to minimize wear and tear. Complete details in this respect shall accompany the tender. Cast iron parts shall have an anti-corrosion coating on the inside and outside. The shaft shall be of stainless steel.
- Rotating elements of the pumps shall be balanced accurately to prevent vibration and noise. Adequate anti-vibration transfer measures shall be incorporated into the system, such as anti-vibration pad mountings to bases and flexible couplings to inlet and outlet.
- Sturdy mild steel bases, adequately corrosion protected by either hot dip galvanising after manufacturing or painted with 1 coat of zinc chromate primer on a clean surface and followed by 2 coats enamel paint of approved manufacture, shall be provided. The pump base shall be filled in with concrete and properly secured to the floor.
- The manufacturer's name, model, serial number, and date of manufacture shall be clearly indicated on the pump body. A test certificate for each pump unit, providing satisfactorily laboratory test runs, shall accompany the delivery of the pumps.
- A complete test of performance characteristics and shop drawings shall be handed to the Engineer and Local Authority for written approval before ordering, supplying and installation commences. This includes flow charts, power consumption-,

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NSPH-, and efficiency curves. General pump curves as supplied by the pump manufacturer are not acceptable.

6.3 MAIN FIRE PUMPS

Two pumps shall be supplied and installed, one equipped with electrical motor and the other with diesel engine.
Each of these pumps shall deliver the full design capacity of the installation.
The Contractor shall select the required pump and submit his calculations and selection to the Engineer and Local Authority for approval prior to ordering.
The main pumps shall be of the centrifugal end-suction type listed for fire protection service. It shall be possible to remove the impellers without removing the pump from its mountings.

The pump shall comply with the following requirements:

- The impeller shall be a single-entry radial impeller and be made of bronze or cast iron.
- The casings shall be of cast iron with renewable casing wear rings. The casing wear rings shall be made of bronze.
- The shaft seals shall comply with the latest edition of ASIB.
- The bearings shall be greasing lubricated anti friction bearings.
- The pump shaft shall be made of stainless steel.
- An auto priming system shall be provided.
- Pump cooling device preventing over heating of pump when operating at closed head.

The performance characteristics of the pump shall be such that the pressure falls progressively with the rate of demand.
Characteristic curves showing capacity, head, efficiency NPSH, power required, and operating range shall be submitted to the Engineer at tender stage. Prior to installation, a complete set of test certificates shall be submitted to the Engineer and Local Authority indicating all performance characteristics of the pump to be installed for approval.
In all cases the pump plate shall give the rated speed for the pressures and flows specified.
For the particular pump concerned the maximum flow rate required. A pressure gauge must be provided downstream of the pump outlet backpressure valve and on the pump suction side. There must be an approved flow test device and pipe connection coupled to the pump delivery branch downstream of the backpressure valve, to facilitate a running flow/pressure test on the pump at approximately the full load condition when the test valve is fully open. This test pipe shall be piped back to the water tank.
The pump shall be operational within 30 seconds after starting.
Sturdy mild steel bases, adequately corrosion protected by either hot dip galvanizing after manufacturing or painted with 1 coat of zinc chromate primer on a clean surface and followed by 2 coats enamel paint of approved manufacture, shall be provided. The pump base shall be filled in with concrete and properly secured to the floor.

6.4 MAIN FIRE WATER PUMP DRIVES

ELECTRIC DRIVE

The electrical motor shall be drip-proof and shall conform to ASIB Twelfth edition. The motor enclosure must at least be according IP55 of IEC 144. High temperature permanent sealed bearings shall be used. The rotation speed of the motor shall not exceed 2950 revs/min.

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DIESEL DRIVE

The diesel engine to be supplied and installed for pump nr 2 shall act as standby to the electrically driven pump. The diesel engine shall be provided with a panel, housing an hour meter tachometer, emergency stop (Latching type) buttons status indication, charger status and double depress start button. These shall only be in operation when the pump is in manual mode. The pump status shall be selected from a key switch or the pump driver panel.
The complete engine and pump set must be tested on the suppliers' test bed and the Engineer and Local Authority shall be given 10 days' notice of the test in order that they witness the test should they so desire.
Copies of a certificate showing the test result of the engine shall be supplied to the Engineer and Local Authority for approval.

NOTE

The pump set shall not be approved if the following has not been received by the Engineer and Local Authority prior to the testing of the pump set:
Provisional pump characteristics with curves showing pressure against flows, absorbed horsepower against flows, pump efficiency against flows and NPSH required against flows for the following circumstances:

- The designed pressures for the flow rates specified.
- The designed pressures and flows for pumps capable of 100%, 120% or 135% of
- the designed duty points.
- The most remote and most favourably design points must be indicated.
- The maximum net positive suction head required by any pump when discharging at the maximum flow rate shall not exceed 5,9 meters.

Should the pump not be capable of meeting any of the design requirements on test, no approval shall be given.

ENGINE

The engine shall be:

- Of the compression ignition mechanical injection type capable of being started without the use of wicks, cartridges, heater plugs or ether, at an engine room temperature of 4°C and must accept full load within 15 seconds from receipt of the signal to start.
- Naturally aspirated and cooled by means of a water-to-water exchanger.
- Capable of operating continuously on full load at the site elevation for a period of 8 hours. The Contractor supplying the pumping set must supply to the Engineer and Local Authority a statement giving the 8 hours b.h.p. rating of the engine at speeds of 1000 revs/min, 1400 revs/min, 1800 revs/min, 2 200 revs/min, 2600 revs/min. and the maximum speed. Any of the speeds quoted which are in excess of the maximum revs/min. rating of the engine may be omitted, and the maximum speed and corresponding rating shall be given.
- Provided with a governor to control the engine speed within 10% of its rated speed under any condition of load up to the full load rating. The governor shall be field adjustable.
- Any manual device fitted to the engine which could prevent the engine starting must return automatically to the reset position for automatic starting.
- Provided with a tachometer and hour meter.

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- Provided with an excess fuel device for the automatic cold starting of the engine. The device is to return automatically to the reset position for automatic starting.
- The coupling between the engine and the pump must allow each unit to be removed without disturbing the other.

COOLING SYSTEM

The cooling system shall be a water-to-water heat exchanger fitted with an integral circulating pump and engine jacket temperature-regulating device.

AIR FILTRATION

The air intake must be fitted with a filter of adequate size to prevent foreign matter entering the engine and must be protected from water discharge where sprinklers are fitted in the engine room.

EXHAUST SYSTEM

The exhaust must be fitted with a suitable silencer and the total back pressure shall not exceed the engine manufacturer's recommendation. Where the exhaust system rises above the engine, means must be provided to prevent any condensate flowing into the engine. The exhaust system must run at least 300mm above engine base plate level. The exhaust system shall be piped to discharge in a safe place outside the building. The exhaust connection to the engine shall be fitted with a welded corrugated flexible connection. The exhaust pipe installation shall be insulated with high-temperature insulation.

ENGINE PRE-HEATERS

Crank case and water jackets shall be provided with heaters, to be operational during engine off times.

FUEL SYSTEM

Fuel:

The engine fuel oil must be Class A to British Standards 2869:1957. There shall be kept on hand at all times sufficient fuel oil to run the engine on full load for eight hours in addition to that in the engine fuel tank.

Fuel tank:

The fuel tank shall be of welded steel conforming to British Standard 814:1961 for mild steel drums. The tank must be mounted above the engine fuel pump to provide a gravity feed. The tank must be fitted with an indicator showing the level of the fuel in the tank. The capacity of the tank must be sufficient to allow the engine to run on fuel load for 8 hours. Additional 8 hours fuel storage shall be provided in a location as indicated by the Engineer.

Fuel feed pipes

Any valve in the fuel feed pipe between the fuel tank and the engine must be placed adjacent to the tank and it shall be locked in the open position. Pipe joints must not be

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soldered, and plastic tubing must not be used, other than that specified by the engine manufacturer.

AUXILIARY EQUIPMENT

The following must be provided:

- A sludge and sediment trap.
- A readily visible fuel level gauge which must not be of glass or plastic tube type. Damage or fracture of the fuel level gauge must not result in fuel spillage.
- An inspection and cleaning hole.
- A filter between the fuel tank and fuel pump mounted in an accessible position for cleaning.
- Means to enable the entire fuel system to be bled of air. Air relief cocks are not allowed, screwed plugs are permitted.

STARTING MECHANISM

Provision shall be made for two separate methods of engine starting. Two separate batteries of adequate capacity must be provided for automatic and manual starting of the engine. Where electric starting is used, the system must operate from a battery supply recommended by the engine supplier.

- Automatic starting shall be by means of a battery powered electric starter motor of the axial displacement type having no retaining catches or inertial features. The pinion must rotate at reduced speed during the process of engagement with the flywheel ring, but during the initial engagement the pinion and armature shaft assembly must mesh by moving axially towards the gear ring. The starting sequence must be initiated by the control system and repeat engagement facilities must be provided should the starter pinion fail to engage with the engine flywheel ring. When the engine fires, the starter motor pinion must be withdrawn from the flywheel ring automatically by means initiated by a directly driven tacho-generator or centrifugal speed switch. Flexible drives are not permitted. Battery charging, voltage generators, alternators and pressure switches on the engine lubricating system or water pump outlet, as a means of de-energizing the starter motor, are not permitted.
- Alternative forms of manual starting: Any other form of manual starting, crank handle, pneumatic, hydraulic, etc. shall be submitted for approval to the Engineer.
- The starter motor in combination with each battery power supply shall have a design capability to rotate the engine for at least 10 cycles of not less than 15 seconds cranking and not more than 6 seconds' rest.

COMPRESSION IGNITION ENGINE DRIVE CONTROLLERS

- All switching equipment for manual use in connecting or disconnecting or starting or stopping the engine shall be externally operable.
- A manually operated isolating switch shall be mounted within the controller enclosure.
- Fuses for protection for both the AC and DC circuits shall be provided and shall conform to BSS 88 as amended.
- Automatic starting shall be initiated by an external monitoring device and the starting components will be arranged to crank for a maximum period of 15

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seconds and dwell for a period of no more than 6 seconds. Both time periods shall be adjustable and set to suit engine and site conditions.

- A presentable counter arranged to count each cranking period shall be provided and shall be capable of being pre-set for up to 9 counts but shall normally be pre-set for 6 counts. If the engine has not started after pre-set number of counts, the cranking must be stopped, and the pump failure indication and alarm must be initiated. Only actual cyclic counters are acceptable. A timer set for the overall calculated time for the pre-set number of starts is not acceptable.
- The components shall be arranged to connect each of the two batteries to the engine starter motor on alternate cranking cycles and so designed that the first cycle of a first attempted start shall alternate between one battery and the other.
- A suitable voltage relay shall be connected across the load side of the main fuses and electrically separate contacts on this relay shall be wired out to clearly identified terminals for initiating the power failure alarm.
- An AC voltmeter shall be provided to indicate the input voltage to the controller.
- A DC voltmeter shall be provided to indicate the terminal voltage of each battery.
- A DC ammeter shall be provided to indicate the charging rate of each battery.
- Electrically separate contacts wired out to clearly identified terminals are to be provided for the following conditions to be monitored:

1. Power failure (battery charger electrical supply)
2. Pump failure
3. Pump running
4. Low oil pressure

Indication in the form of duplicate indicating lamps shall be provided to show the following:

1. Pump failure
2. Pump running
3. Low oil pressure

- A reset push button shall be provided to reset the controller.
- The controller shall latch on to a starting signal until the reset push button is pressed.
- One "emergency start" push button shall be provided for each battery and the circuitry shall be arranged so that each push button will bypass the automatic starting circuit and will energize its associated starter motor solenoid. It shall be possible to depress both push buttons and apply power from both batteries simultaneously to the starter motor.
- An adjustable voltage sensitive device shall be provided to sense the potential generated by the tacho-generator mentioned in the specification.
- Manual isolating and/or selector switches in the battery to engine starter motor circuits are not permitted.
- A separate test button shall be provided to initiate the automatic starting sequence.
- Controllers mounted on the engine bedplate shall be supported by a substantial frame securely bolted to the engine bedplate and the controllers shall be secured to this frame by means of approved resilient mountings.
- Plug-in components such as fuses, relays, p.c. boards, etc., in controllers which are mounted on the engine bedplates shall be provided with suitable spring clips or securing facilities to prevent unplugging due to vibration.

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- Batteries shall be mounted and securely clamped on stands or stillages and located in a readily accessible position where the likelihood of contamination by oil, fuel, damp, pump set cooling water or being damaged by vibration, is unlikely. The battery should be installed as close to the starter motor as possible to minimize voltage drop between the battery and starter motor terminals. The batteries shall be mounted on a wooden base.
- Heavy current solenoid operated contactors for connecting the battery to the engine starter motor shall be located on the engine or bedplate immediately adjacent to the engine starter motor or batteries.
- All DC electrical components shall be capable of functioning effectively at the reduced voltage levels that exist during cranking. Relays shall not chatter on drop-out and solid-state circuits shall not "switch" under these low voltage conditions.
- The battery voltage shall be as specified by the engine manufacturers.
- The control circuit shall be arranged to operate across the full battery voltage. Connections for any reduced voltages shall not be taken by tapping-off cells in the battery.

6.5 MAIN ELECTRIC CONTROL PANEL

- The electric control panel to be supplied and installed shall comply with the Local Authorities regulations, codes and ASIB Twelfth edition. This panel and electrical installation shall adhere to all relevant regulations, codes, by-laws and laws as set out in above specification and applicable to the installation. The electric control panel shall be of the indoor floor standing type and shall be vermin and insect proof, drip proof and dust proof to at least Class IP 55. Unless otherwise specified the control panel shall be equipped with a lockable hinged door(s) and lockable facia panel and a bolted removable back plate. The panel shall be finished with a powder coated finish or baked enamel system with the interior of the panel in a brilliant white colour and the rest of the panel in a fire red colour. It shall have a top cable entry removable gland plate. Power and control cables shall be grouped together.
- The panel shall be designed and manufactured to automatically control the whole system as set out above and shall easily house at least the following equipment: (with a 30% spare space allowed)
- Main isolating switch, with label to indicate to switch off in case of emergency, on the facia panel.
- Suitable circuit breakers for pumps and control circuit with correct fault current rating, on back plate with faces protruding through facia panel.
- Suitable contactor for jockey pump and star delta starting arrangement for main electrical driven pump.
- Suitable thermal overloads for pumps.
- Supply for diesel driven pump control panel and battery charger.
- All control equipment necessary for the complete automatic control of system (i.e. relays, selector switches, push buttons, indicator lights, etc.), on facia panel and back plate.
- Voltmeter with selector switch to monitor voltages between each current phase and neutral and between phases (min 65mm), on facia panel.
- Ammeter with selector switch to monitor each phase (min 65mm), on facia panel.
- Indicator lights for all fault, on/off and automatic conditions, on facia panel.
- Alarm for major faults conditions, on top of control board.
- Water storage tank level monitoring indication and devices
- Alarm accept and reset buttons, on facia panel.

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- 24 Volt low voltage circuit for low water level and high-level float switch in tank and diesel engine starting and control circuit.
- Lightning arrestors/surge suppressors on all lines and neutral, on back plate.
- Remote alarm starts and stop system wired back to fire station control room.

- Labels, with black lettering on white background, shall be securely fitted to indicate the name and function of the components and other relevant information e.g. "stop", "start", "Pump 1" etc. The minimum letter size shall be 5mm.
- The Contractor shall ensure before manufacturing of control panel that the fault current rating of panel is with-in the limits of this particular installation.
- The electric control panel shall be tested and inspected before leaving the manufacturer.
- Before any ordering, manufacturing, supplying and/or installation commences, the complete offered system shall be checked and reviewed by the Engineer in writing. Full details and 3 sets of drawings showing wiring diagram, component lists, panel dimensions and layout shall be supplied to the Engineer for this purpose.
- The electrical installation shall be carried out in accordance with the latest edition of the Local Authorities regulations and codes.
- In addition to the components mentioned in the above and this specification, at least the following shall be incorporated in the control circuit on the hinged front panel.
- Adequately sized led type indicators at a visible position in the distribution board (min 20Ø).

One set for each pump indicating:

- Pump off — Red
- Pump running — Green
- Pump tripped — Orange-flickering (including alarm)
- Pump automatic — Yellow
- Pump manual — Yellow
- Water low — Orange-flickering (including alarm)
- Water overflow — Orange-flickering (including alarm)
- Power supply adequate — Red

METERS

- 1 x Volts — 0 - 400 Volt (min 65mm)
- 3 x Amps — Amps as required (min 65mm)

Selector switches for:

- Pump: manual, off or automatic selection for each pump.
- Voltmeter between phases and phases and neutral and off selection.

Push buttons for :(min Ø20 dia)

- Alarm accepts. (black)
- Alarm reset button. (black)
- Indicator and alarm test buttons. (yellow)
- Pump start and stop. (green; red)

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- Proper labels indicating functions of components and other relevant information e.g. voltage, pump 1 etc. (min 3mm high characters).
- An audible alarm of the flashing strobe type shall be mounted outside the pump room panel for fault condition and pump running signalling. The alarm shall be of a kind and so situated that it produces a sound level of at least 110 dBA at a distance of more than 1 m.
- In all cases the malfunction indicators shall only be activated in the event of a fault condition and stay in operation until reset manually at the switchboard, while auto resetting protection equipment shall keep the pump in working order (except for thermal overload). Flickering and/or flashing emergency lights/indicators refer to malfunction conditions, while a constant signal serves for monitoring purposes.
- Provision shall be made for test button(s) activating all signals, in order to test functioning; (alarm and monitoring circuits).

Remote fault and status signals for all equipment shall be provided on this control panel to be relayed back to the fire detection system.

7. DIVISIONS OF WORK SCHEDULE

The following work related to this Contract shall be provided by others to the Contractor's requirements.
Principal Building contractor

- All openings in the structure, brick walls, bulkheads, and partitions.
- Building-in of pipe sleeves.
- All plinths.
- Concrete tanks
- Tank lining

Electrical Contractor

- A 3-phase power supply to maintenance isolator where the fire contractor shall install his electrical distribution panels.
- General lighting and power in fire pump rooms.
- Fire detection interface modules for flow switches, alarm signals, and fault signals.

8. DETAILED PROJECT SPECIFICATION

The work to be carried out under this contract shall include the following installations:

- Suction hudrant and Booster Connections
- Wet Pipe Fire Hydrants and Hose Reel Installation (internally & extarnally)
- Portable Fire Extinguisher Installation
- All electrical controls, cabling, strobes and sirens where applicable
- Test water drain pipework to the catchpit drain
- Diesel and Electric pumps

The works shall commence at the main supply, provided by others at the tank infill, and terminate at the hydrants and fire hose reels.

This is to include all:

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▪ Design	▪ Setting out	▪ Commissioning into service
▪ Manufacture	▪ Fitting and fixing in position	▪ Return of packings
▪ Supply	▪ Temporary works	▪ Establishment charges
▪ Conveying and delivering	▪ Cutting and waste	▪ Protection and removal thereof on completion
▪ Unloading and unpacking	▪ Patterns	▪ Cleaning down complete
▪ Storing	▪ Templates	▪ Training
▪ Hoisting	▪ Plant	▪ Handing over in complete working order, to the satisfaction of the Engineer and Local Authorities.
▪ Scaffolding	▪ Painting	▪ Certification
▪ Coordination	▪ Testing	▪ Guarantee and maintenance

The above work equipment shall be of new high-quality material, design, and manufacture, suitable for providing an efficient, reliable, and trouble-free service.

The work to be carried out under this contract shall include, but not be limited to the following:

- Conventional fire water system including landing valves and fire hose reels inside the building.
- Portable fire extinguishers as indicated on the drawings to meet SANS standards.

Fire water pumps installation, consisting out of the following:

2 off Main fire pumps sets -one diesel driven main pump
-one electrical driven main pump

- Jockey pump set - one electrical driven jockey pumps.
- Electrical control panels including electric, diesel, jockey pumps and annunciator control panels.
- All associated pipes work as indicated on the drawings.
- All electrical controls, cabling, and interfacing to all supervised equipment.
- Fire water storage tanks ancillary equipment, including vortex inhibitors, cat ladders, level indicators, tank fill points and tank suction points, automatic fill valves and associated pipe work to and from reinforced concrete fire water storage tanks.
- Flow switches and supervisory switches.
- Flashing strobe and siren.
- Fire hoses and streamers.
- Testing of the complete fire water systems including fire pump room installation.
- Co-ordination of the complete fire water system relative to other services including the mechanical, electrical, and plumbing services, as well as structure.
- Painting of all fire water piping and equipment.
- Fire stopping devices.
- Statutory fire signage as indicated on the relevant drawings.
- Installation and shop drawings for approval by the Engineer and Local Authority.

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- Certification of the complete installation as complying with Local Authority requirements and all relevant codes and regulations as highlighted in this document.
- Supplying of operating and maintenance manuals for all systems and components of this installation.
- Training of client's maintenance and operating personnel in operating, servicing, and maintaining the systems and components forming part of this installation.
- Commissioning and handing over of complete systems to the satisfaction of the Engineer.
- Maintaining and servicing of complete installations during the warranty period.

9. SYSTEM DESCRIPTION

9.1 GENERAL

The design as indicated on the tender drawings shall be checked by the Tenderers against the latest requirements for the Standards and Local Authority. Tenderers shall allow for all required amendments to the design to ensure that it is in accordance with the relevant Rules and Regulations.

These amendments shall be indicated in red on the tender drawings, which are to be returned with the tender documents, and noted in a tender covering letter. The Tendered Subcontract Sum shall include the relevant costs, if any, for the above amendments.
This building shall be protected by means of a conventional fire water and fire extinguishing systems, designed, supplied, installed, tested, and commissioned in accordance with the relevant codes, regulations, and requirements of the Local Authorities.

The conventional wet pipe firefighting systems shall be installed in accordance with the relevant codes and regulations described in this document as well as the design drawings provided. The water supplies to this installation shall consist out of a private reservoir and fire pump systems situated inside the pump plant room. This fire pump systems shall also provide water to the site fire water reticulation networks.

Fire pump room area to be equipped with standard response pendant type sprinklers as indicated from the drawings.

Fire hose reels, fire extinguishers and fire hydrants to be installed according to the relevant SANS Standards and the requirements of the Local Authorities in positions as indicated on the drawings.

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10. DETAIL DESIGN INFORMATION

10.1 FIRE PUMP SYSTEMS

Hydraulic calculations done by the contractor shall confirm the below prior to ordering pumps and tanks to ensure minimum effective capacities are achieved:

FIRE PUMP - SYSTEM No. 1		
Required Delivery Flow rate:	2800 litres/minute	
Required Downstream Pressure:	600 kPa	
Dedicated Fire Water Storage:	147 m³	
Number of Pumps	1 Jockeys & 2 Main Pumps (One diesel and one Electrical driven)	
JOCKEY PUMP - SYSTEM No. 1		
Number of pumps:	1	
Pump Capacity / pump:	Closed Head:	+/- 1,150 kPa
	Flow and Pressure not to exceed:	+/- 2ℓ/sec @ 600 kPa
Type of Pumps:	Vertical multi-stage	
MAIN DIESEL DRIVEN PUMP - SYSTEM No. 1		
Number of pumps:	1	
Pump Capacity / pump:	Closed Head:	+/- 1,000 kPa
	Duty Point:	2800 ℓ/min @ 850 kPa
Type of Pumps:	End-Suction Diesel Driven	
MAIN ELECTRICAL DRIVEN PUMP - SYSTEM No. 1		
Number of pumps:	1	
Pump Capacity / pump:	Closed Head:	+/- 1,000 kPa
	Duty Point:	2800 ℓ/min @ 800 kPa
Type of Pumps:	End-Suction Electrical Driven	
SURGE ANTICIPATOR AND RELIEF VALVE- SYSTEM No. 1		
Number:	1	
Relief Pressure Setting:	1000 kPa	
Relief Flow rate:	2800 ℓ/min	
ELECTRICAL POWER REQUIREMENTS - SYSTEM No. 1		

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[redacted]

Normal Power:	75 kW, 400 Volt, 50 Hz, 3 phase + neutral, fault rating to be confirmed by Elect. Eng., 200 Amp D curve Breaker neutral and earth.
Standby Power:	YES

10.2 CONVENTIONAL FIRE PROTECTION INSTALLATIONS

Hydrant and Hose reel Installation to SANS 1567 and SANS 543.
Portable Fire Extinguishers shall be installed to SANS 1910.

10.3 PIPING SPECIFICATION

The following piping and fittings shall be used for this project and shall comply with the local Authorities requirements and shall be as specified in the Technical included in this document:

Conventional Fire Protection system:

Pipe sizes up to 50mm dia.

Medium grade steel screwed and socketed pipe in accordance with BS 1387, with malleable cast iron screwed and socketed fittings.

Pipe sizes larger than 50mm dia.

Medium grade steel plain-ended pipe in accordance with BS 1387 to be joined by means of rolled groove ends with flexible couplings and fittings. Welded plain-ended black steel piping and wrought iron weld on fittings shall only be used where approved by the Engineer.

10.4 GENERAL

In addition to the Technical Specification included in this document, the following shall apply to sprinkler systems:

(a) Only piping 50mm diameter and larger may be permitted to be joined together by welding. This is provided that the joints are fabricated and welded in the workshops of the Contractor whose welding procedures shall be approved by a recognised authority. No welding or heat cutting shall be permitted on the site.

(b) No sprinkler piping shall be embedded in the structure, nor shall it be concealed in any situation where difficulty would be involved in making alterations or additions which may subsequently become necessary.

(c) Where pipework is erected in locations where it is prone to damage and it is unpractical to avoid such areas, the pipework shall be protected by adequate guards. The method of protection shall be approved by the Engineer.

10.5 PIPE SUPPORTS

In addition to the Technical Specification included in this document, the following shall apply to both pump room sprinkler and fire water systems:

(a) Purpose structurally designed and manufactured support brackets shall be supplied and installed for the main distribution and riser piping where they are

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bunched together. This shall consist out of galvanised angle iron frames fitted with U-bolts anchored to building structure.

(b) Purpose structurally designed and manufactured support brackets shall be supplied and installed for the sprinkler/fire pump piping installation. This shall consist out of galvanised angle iron frames fitted with U-bolts anchored to building structure.

10.6 VALVES SPECIFICATIONS

(a) **Valves > 50mm dia.**

Shall be of the butterfly valve type with resilient rubber seat and shall be equipped with gear operated closing mechanism. The valves shall be in accordance with BS 5155 and shall be similar or equally approved to Victaulic groove ended or flanged valves fitted with supervisory micro switches which shall be wired back to the fire control panel by others.

(b) **Valves smaller and equal to 50mm dia.**

These valves shall be of the screwed and socketed type with bronze body and gates with non-rising spindle.

10.7 PUMP ROOM EQUIPMENT AND INSTALLATION SPECIFICATION

The fire pump installation shall be equipped with sprinkler/fire water pump system, situated inside the sprinkler pump room, consisting out of the following:

- Jockey pump set.
- Main electrical driven fire pump.
- Main diesel driven fire pump.
- Jockey, electrical and diesel fire pump drive control panels.
- Annunciator panel.
- Automatic pressure switch starting arrangements.
- Diesel storage tank with a storage capacity of at least 8-hours running time of the diesel driven pump at 100% capacity.
- All required pipework, valves, non-return valves, pressure gauges, strainers, bracketing, supports etc. for the complete installation required and as indicated on the plan and schematic layouts.
- All electrical cabling, wiring, cable ways, controls, level indicating equipment, float switches etc. for the complete pump room installation.
- Flow test arrangement installation.
- Engine cooling and pump cooling installation.

This installation shall be installed in accordance with ASIB Twelfth Edition and Local Authority requirements.

10.8 JOCKEY PUMP SET

The fire pump system shall be provided with a jockey pump set with a capacity as follows:

Jockey pump sets to consist out of two identical pumps coupled in parallel and controlled by means of pressure starting switch arrangement ensuring the system is kept at a pressure of 600 kPa. Each pump shall have a flow capacity of 2 litre/second at 600 kPa.

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10.9 MAIN DIESEL ELECTRIC DRIVEN PUMP SET

Each main electrical driven fire pump shall be of the centrifugal end-suction type capable of providing the required flow and pressure of the entire development.

The estimated pump capacity of the Hydrant Pump is 2800 litres/minute at a dynamic head of 850 kPa.

The drive controller for this pump set shall be in accordance with the Technical Specification and shall be mounted inside the Main Electrical Driven fire pump control panel.

The Contractor shall provide full-certified hydraulic calculations to enable exact sizing of the pumps.

10.10 MAIN DIESEL ELECTRIC DRIVEN PUMP SET

Each main diesel driven fire pump shall be of the centrifugal end-suction type capable of providing the required flow and pressure of the entire development.

The estimated pump capacity of the Hydrant Pump is 2800 litres/minute at a dynamic head of 850 kPa.

The diesel engine shall be of the compression ignition mechanical injection naturally aspirated type and cooled by means of a water-to-water exchanger. This diesel engine and ancillary equipment shall comply with the Local Authorities requirements and the Technical Specification included in this document.

The drive controller for this pump set shall be in accordance with the Technical Specification and shall be mounted inside the Main Diesel Driven fire pump control panel.

The Contractor shall provide full-certified hydraulic calculations to enable exact sizing of the pumps.

10.11 CONVENTIONAL FIRE PROTECTION EQUIPMENT SPECIFICATION

The conventional firefighting installation shall be installed in accordance with technical specification - conventional firefighting Installations, SANS 1567, SANS 543, SANS 1910, and the requirements of the Local Authorities.

10.12 LOCATION PLANS

The Contractor shall provide and install a plan of the reticulation indicating zoned areas, etc. to local authority requirements.

The plan shall be fully legible and shall be in a location where it can be readily seen by firemen and others responding to a fire alarm. Final location of this plan shall be approved by the Engineer.

The fire water installation control and booster cabinet shall be equipped with the following note "Installation Booster for Hydrant Systems".

10.13 PROVISIONING FOR COMMISIONING

It must be noted that all power, water, and specialist tools for the proper commissioning of the system shall be allowed for by the tenderer.

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11. TECHNICAL DATA SCHEDULES

MATERIALS AND EQUIPMENT WHICH MIGHT BE PROCURED, SUPPLIED, AND INSTALLED UNDER THIS CONTRACT

The tenderer shall provide the following information completed in BLACK INK at tender stage.

Butterfly valves > 50 mm dia.

Manufacturer	
Type	
Model	
Country of origin	
Valve body material	
Butterfly material	
Rated working pressure (kPa)	

Globe valves ≤ 50 mm dia.

Manufacturer	
Type	
Model	
Country of origin	
Valve body material	
Wedge material	
Rated working pressure (kPa)	

Strainers

Manufacturer	
Type	
Model	
Country of origin	
Body material	
Strainer element material	
Rated working pressure (kPa)	

Non-Return valves

Manufacturer	
Type	
Model	
Country of origin	
Valve body material	
Type of check and material	
Rated working pressure (kPa)	

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[redacted]

Pressure gauges

Manufacturer	
Type	
Model	
Country of origin	
Pressure range	
Rated working pressure (kPa)	

Piping > 50 mm dia

Manufacturer	
Type	
Code and class	
Country of origin	
Method of jointing	
Rated working pressure (kPa)	

Piping ≤ 50 mm dia

Manufacturer	
Type	
Code and class	
Country of origin	
Method of jointing	
Rated working pressure (kPa)	

Installation alarm control valves

Manufacturer:	
Country of Origin:	
Model Nr:	
Valve box material:	
Valve size:	

Fire Department Booster Connection

Manufacturer:	
Country of Origin:	
Model Nr:	
Number of Inlets	
Type	
Size:	

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[redacted]

Fire Extinguisher (DCP)

Manufacturer:	
Country of Origin:	
Model Nr:	
Size:	

Fire Extinguisher (WET)

Manufacturer:	
Country of Origin:	
Model Nr:	
Size:	

Fire Extinguisher (CO2)

Manufacturer:	
Country of Origin:	
Model nr:	
Size:	

External Fire Hydrant

Manufacturer:	
Country of Origin:	
Model Nr:	
Hose Connection Type	
Type:	
Size:	

Fire Hose Reel

Manufacturer:	
Country of Origin:	
Model Nr:	
Hose length:	
Hose Material:	
:	

Nozzle

Manufacturer:	
Country of Origin:	
Model Nr:	
Type:	
Valve size:	

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12. FIRE PUMP AND STORAGE INSTALLATION

Main fire pumps

Manufacturer:	
Model:	
Country of origin:	
Type of pump:	
Impellor type:	
Impellor size:	
Impellor material:	
Inlet coupling size:	
Outlet coupling size:	
Closed coupled:	
Pump casing material:	
Pump operating pressure:	
Pressure at operating point (mH_2O):	
Pressure height against no flow (mH_2O):	
Maximum flow (mH_2O):	
Flow and pressure against most effective operating point:	

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[redacted]

Compression ignition engine for pump P2

Manufacturer:	
Model:	
Country of origin:	
Fuel system:	
Method of aspiration:	
Method of engine speed control:	
Cold starting device:	
Oil heater:	
Water jacket heater:	
Method of engine cooling:	
Cooling medium flow rate:	
Cooling medium pipe size:	
Method of air filtration:	
Rated power output at full load:	
Engine speed at max. power:	
Engine speed at operating point:	
Power output at operating point:	
Control panel model:	
Battery system:	
Battery charger model:	
Type of coupling between engine & pump:	
Weight completes with pump:	
Dimensions complete with pump:	

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Electrical motor for pump P1

Manufacturer:	
Model:	
Country of origin:	
Class of water protection:	
Rated output:	
Rated voltage:	
Rated full load current:	
Rated load factor against full load:	
Rated frequency:	
Type of motor:	
Rotation speed:	
Starting method:	
Motor cooling method:	
Nett mass:	
Motor cooling method:	
Nett mass:	
Pump:	
Manufacturer:	
Model:	
Country of origin:	
Type of pump:	
Impellor type:	
Impellor size:	
Impellor material:	
Inlet coupling size:	
Outlet coupling size:	
Closed coupled:	
Pump casing material:	
Pressure height against no flow:	
Maximum flow:	
Flow and pressure height against most effective operating point:	

Main Electrical Control Panel

Manufacturer:	
Type:	
Fault current:	
Size:	
EQUIPMENT	
Main isolator:	
Circuit breakers:	
Contactors:	

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[redacted]

Thermal overload:	
Ammeters:	
Voltmeters:	
Indication lights:	
Selector switches:	
Over and under	
Voltage relay:	
Time switch:	
Hour meter:	
Lightning arrestors:	
Stop/start switches:	

COMPANY: _____

ADDRESS _____

_____

_____

PHONE NUMBER: _____

FAX NUMBER: _____

NAME: _____

SIGNED ON BEHALF OF THE TENDERER: _____

DATE: _____

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APPENDIX A – SCHEDULE OF DRAWINGS

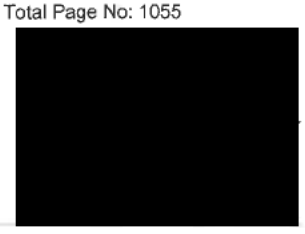
- 1001757-2000-DRG-FI-2795 [T0] ON-SITE ELECTRO CHLORINATION BUILDING FIRE SAFETY FLOOR PLAN
- 1001757-2000-DRG-FI-2796 [T0] ON-SITE ELECTRO CHLORINATION FIRE WATER PUMP ROOM FLOOR PLAN
- 1001757-2000-DRG-FI-2855 [T0] ADMINSTRATION BUILDING FIRE SAFETY FLOOR PLAN
- 1001757-2000-DRG-FI-2899 [T0] GAURDHOUSE FIRE SAFETY FLOOR PLAN

The tenderers shall confirm that they have received the above drawings by signing hereunder.

.....

TENDERER's SIGNATURE

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SPECIFICATION: SPE-FI-0002

FIRE STOPPING

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2.1 SERVICE SHAFTS 3
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[redacted]

1. GENERAL

Comply with General Requirements and all documents referred to therein.

Applicable to the following buildings under this tender package:

The following fire stopping drawings forms part of this tender and are to be referenced

- 1001757-2000-DRG-FI-2795 [T0] ON-SITE ELECTRO CHLORINATION BUILDING FIRE SAFETY FLOOR PLAN
- 1001757-2000-DRG-FI-2796 [T0] ON-SITE ELECTRO CHLORINATION FIRE WATER PUMP ROOM FLOOR PLAN
- 1001757-2000-DRG-FI-2855 [T0] ADMINSTRATION BUILDING FIRE SAFETY FLOOR PLAN
- 1001757-2000-DRG-FI-2899 [T0] GAURDHOUSE FIRE SAFETY FLOOR PLAN

The responsibility for the accuracy of the quantities written into the Schedule of Quantities remains with the tenderer. The tenderer shall be responsible for the measuring of quantities. He will be required to make his assessment of all items as required for a complete and fully functional installation in accordance with the specifications and services drawings.

The Schedule of Quantities is to be based on all the tender drawings as issued as part of the tender.

Revisions to the drawings may be carried out during the course of the construction period. These revisions in quantities are to be recorded as additions and omissions and will be priced at the applicable rates in the Schedule of Quantities. No adjustments will however be made to rates for these variations in quantities.

The scope of the works, as also indicated on the drawings, and including all manufacturing, conveying and delivering, unloading, storing, unpacking, hoisting, scaffolding, setting out, fitting and fixing in position, cutting, waste, patterns, templates, plant, temporary works, commissioning, return of packing, establishment charges, protection and removal thereof on completion, cleaning down complete, handing over in proper working order, maintaining for the period specified and other obligations arising out of the conditions of contract for the Fire Stopping installation.

The tender submitted must be based on the specifications and materials as detailed in the tender document and relevant drawings. Should tenderers wish to offer any alternative which may result in savings to the subcontract then all such savings must be outlined in a separate letter accompanying the tender submission. Full details must be provided for such an offer at the time of tendering.

The information and detail as indicated on the tender drawings will take preference over the tender document in the event of any discrepancies.

The tenderer shall submit with their tender all the relevant technical information relating to their fire stopping systems/products offered. All systems offered and priced for shall be accompanied by their respective test reports prepared in accordance with the requirements of BS or EN equivalent.

Furthermore, all proposed systems shall also be accompanied with a technical report containing the intended application, installation method and its certification – all at tender stage.

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[redacted]

1.1 WORKSHOP DRAWINGS

Installation fit is an engineering function, and not a system design function. The Fire Stopping subcontractor shall undertake the required engineering and co- ordination during the preparation of shop drawings in co-ordinating services to suit service spaces provided. Such engineering shall include co-ordination with other contractors taking into account the services installation sequence programme.

All workshop drawings shall be approved and signed off by the sub-contractor's project manager.

1.2 SCHEDULE OF PARTICULARS AND INFORMATION

Fire stopping systems and products offered shall be listed on a schedule and accompany the tender submission with full technical detail, data, drawings, intended application, installation instructions and certification. All fire stopping systems shall be capable of performing the specified duties and complying with the specification requirements in all respects; should it transpire that such fire stopping systems and products, even when offered by make, and type, is unsuitable of meeting, or performing in accordance with the specification requirements in any respect, the Fire Stopping subcontractor shall nevertheless be responsible for any additional costs incurred in providing the required or suitable fire stopping.

1.3 PERFOMANCE

The responsibility for the performance of the installation according to this specification lies with the Fire Stopping subcontractor. The Fire Stopping subcontractor shall therefore satisfy him that the requirements are practical, workable and achievable.

2. DESCRIPTION OF THE WORKS

A full set of Rational Fire Design drawings for the buildings form part of this tender, as well as a typical fire stopping detail drawing.
All fire rated walls (i.e. 240, 120-, 90-, 60- and 30-minute fire rated) are indicated on these drawings.
Each floor slab is a fire separation and fire rated for 120 minutes, unless stated otherwise.
A set of structural steel drawings is provided that indicate the location and size of the exposed steel members that need to be treated to achieve a 120-minute fire rating.
The Fire Stopping subcontractor shall ensure and price for the fire stopping system associated with the applicable requirements in terms of the fire rating (Rational Fire Design Drawings) and the services penetration types.

2.1 SERVICE SHAFTS

The walls of all internal service shafts shall have a fire resistance of 60 minutes unless stated otherwise.
Service shafts shall be fire stopped at every level above the bottom of such shaft – the fire resistance shall be 60 minutes unless stated otherwise.
Fully enclosed service shafts with a fire resistance of 60 minutes, used for ventilation will have no fire stops in the shafts except where the duct leaves such shaft to penetrate adjacent areas.

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3. STATUTORY REQUIREMENTS

The tenderer shall price and ensure that the entire fire stopping installation is in full compliance with all the relevant statutory requirements.
The design as indicated on the tender drawings shall be checked by the Tenderers against the statutory requirements. Tenderers shall allow for all required amendments to the design to ensure that it is in accordance with the relevant regulations.
These amendments shall be indicated in red on the tender drawings, which are to be returned with the tender documents, and noted in a tender covering letter. The Tendered Subcontract Sum shall include the relevant costs, if any, for the above amendments.

4. SYSTEM CHECKOUT AND TESTING

4.1 TESTING

The Fire Stopping subcontractor shall carry out regular in-depth inspections and tests on site inspecting and testing the full scope of works. All commissioning and tests results shall be submitted to the Fire Engineer prior to acceptance taking place. The acceptance tests shall demonstrate compliance of the contract works to specification requirements.
Written reports of these tests and inspections shall be issued to the Fire Engineer. The reports shall cover the entire scope of works and shall include comments with regard to both defective and correct works.
A programme with test and inspection dates and venues shall be drawn up and issued to the Fire Engineer prior to commencement of any installation and test processes.
All pre-commissioning, commissioning and quality monitoring shall be undertaken in accordance the relevant Commissioning Codes.

4.2 MAINTENANCE

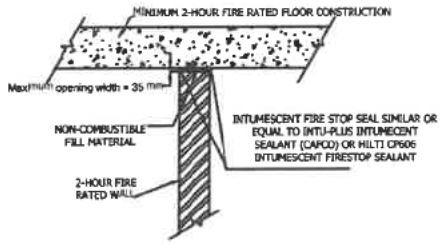
Comprehensive written reports including repairing of defects, adjustments, etc. and covering all routine maintenance shall be issued to the Fire Engineer during the 12-months period after practical completion. Written reports of all callouts shall be issued to the Fire Engineer, including rectification work undertaken and the reasons for the call-out.

See Typical fire stopping application details below.

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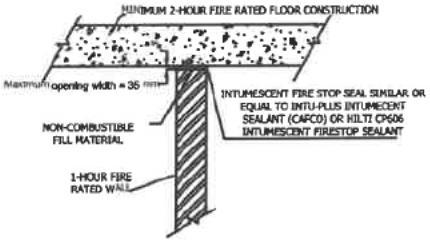
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5. TYPICAL FIRE STOPPING DETAILS



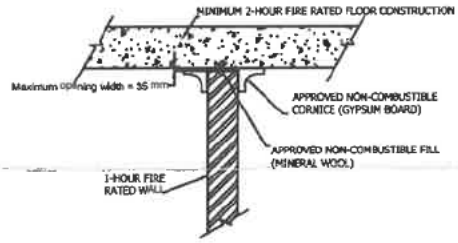
DETAIL FPS - A1

FIRE STOPPING DETAIL FOR 2-HOUR FIRE WALL JOINING WITH 2-HOUR FLOOR



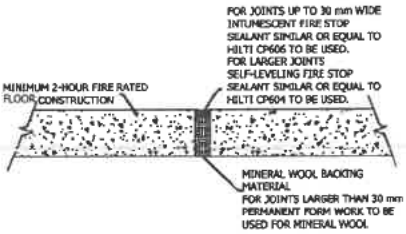
DETAIL FPS - A2

FIRE STOPPING DETAIL FOR 1-HOUR FIRE WALL JOINING WITH 1 0R 2-HOUR FLOOR



DETAIL FPS - A3

FIRE STOPPING DETAIL FOR 1-HOUR FIRE WALL WHERE GYPSUM TYPE CORNICES ARE USED BETWEEN SOFFITS AND WALL

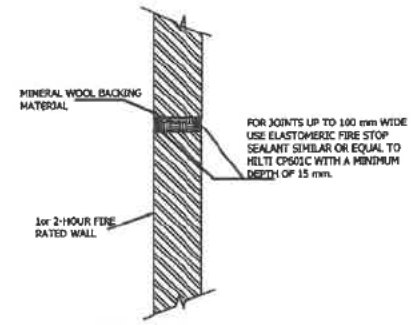


DETAIL FPS - A4

FIRE STOPPING DETAIL FOR FLOOR JOINTS

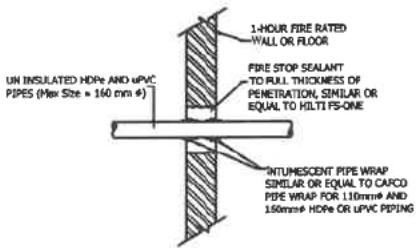
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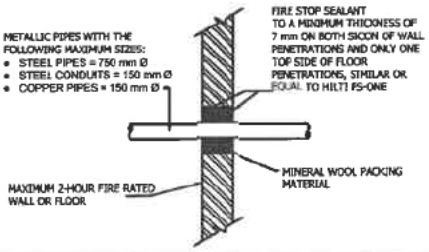
DETAIL FPS - A5

FIRE STOPPING DETAIL FOR FIRE RATED WALL JOINTS



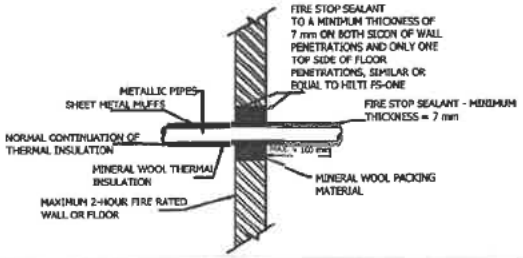
DETAIL FPS - A6

FIRE STOPPING DETAIL FOR HDPe OR uPVC PIPE PENETRATION THROUGH 1-HOUR WALL OR FLOOR



DETAIL FPS - A7

FIRE STOPPING DETAIL FOR METALLIC PIPE AND CONDUIT PENETRATION THROUGH A MAXIMUM 2-HOUR WALL OR FLOOR

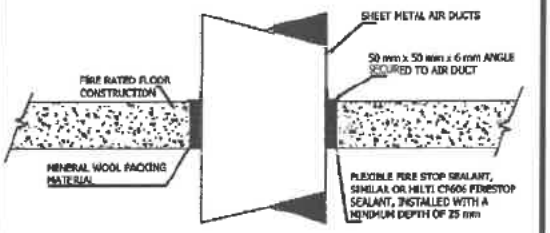


DETAIL FPS - A8

FIRE STOPPING DETAIL FOR INSULATED METALLIC PIPE PENETRATION THROUGH A MAXIMUM 2-HOUR WALL OR FLOOR

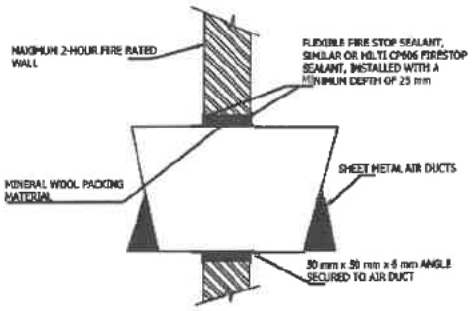
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[redacted]



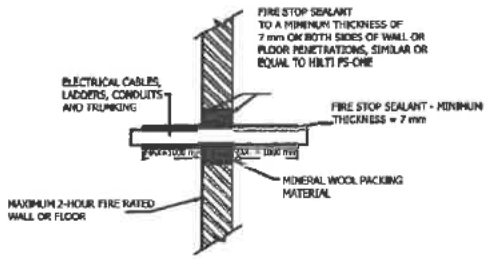
DETAIL FPS - A9

FIRE STOPPING DETAIL FOR AIR DUCT PENETRATIONS THROUGH A MAXIMUM 2-HOUR FLOOR



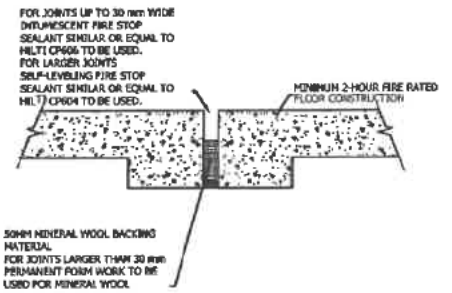
DETAIL FPS - A10

FIRE STOPPING DETAIL FOR AIR DUCT PENETRATIONS THROUGH A MAXIMUM 2-HOUR WALL



DETAIL FPS - A11

FIRE STOPPING DETAIL FOR INSULATED ELECTRICAL CABLES, LADDERS, CONDUITS AND TRUNKING PENETRATIONS THROUGH A MAXIMUM 2-HOUR WALL OR FLOOR

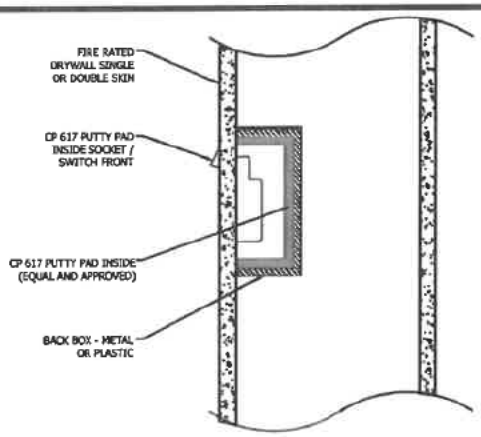


DETAIL FPS - A12

FIRE STOPPING DETAIL FOR FLOOR JOINTS

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[redacted]



DETAIL FPS - A13

FIRE STOPPING DETAIL - INSTUMESCENT ACOUSTIC PUTTY PAD FOR LIGHT WEIGHT PARTITION ELECTRICAL BOXES AND SWITCHES

FIRE STOPPING AND PENETRATION PROTECTION NOTES

A **GENERAL**

1. REFER TO THE FIRE SAFETY DRAWINGS AND FIRE SAFETY REPORT FOR THE REQUIREMENTS OF THE FIRE BARRIER SEALING, SMOKE SEALING AND PENETRATION AND OPENING PROTECTION
2. THE SUPPLY, INSTALLATION AND APPLICATION OF ALL FIRE/SMOKE STOPPING AND SEALING SHALL ADHERE TO THE FOLLOWING CODES AND REQUIREMENTS:
   - SANS 10400-PART T
   - NFPA 5000 IN PARTICULAR CHAPTER 8 - FIRE-RESISTIVE MATERIALS AND CONSTRUCTION
   - UNDER WRITERS LABORATORIES FIRE RESISTANCE DIRECTORY
   - FIRE STOP SYSTEMS OR DEVICES SHALL BE TESTED IN ACCORDANCE WITH ASTM E 814 - STANDARD TEST METHOD FOR FIRE TESTS THROUGH-PENETRATION FIRE STOPS, OR UL 1479 - STANDARD FOR FIRE SAFETY FOR FIRE TESTS OF THROUGH-PENETRATION FIRE STOPS.
   - ALL GOVERNING LOCAL BUILDING CODES
3. ALL FIRE RATED THROUGH-PENETRATIONS SHALL BE LABELED
4. THIS DRAWING AND NOTES SHALL BE READ IN CONJUNCTION WITH THE RELEVANT PROJECT SPECIFICATIONS AND DRAWINGS
5. ALL FIRE STOP SYSTEMS AND DEVICES SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS REQUIREMENTS.

B **PENETRATIONS - FIRE BARRIERS**

1. ALL OPENINGS, PIPES, CONDUITS, BUS DUCTS, CABLES, WIRES, AIR DUCTS, PNEUMATIC TUBES AND DUCTS, AND SIMILAR BUILDING SERVICE EQUIPMENT PENETRATIONS THAT PASSES THROUGH A FIRE BARRIER SHALL BE PROTECTED BY FILLING THE SPACE BETWEEN THE PENETRATING ITEM AND THE FIRE BARRIER, BY MEANS OF A MATERIAL THAT IS CAPABLE OF MAINTAINING THE FIRE RESISTANCE OF THE FIRE BARRIER OR BY AN APPROVED DEVICE WHICH SHALL MAINTAIN THE FIRE RESISTANCE OF THE FIRE BARRIER.
2. WHERE THE PENETRATING ITEM USES A SLEEVE TO PENETRATE THE FIRE BARRIER, THE SLEEVE SHALL BE SOLIDLY SET IN THE FIRE BARRIER, AND THE SPACE BETWEEN THE ITEM AND THE SLEEVE SHALL BE FILLED WITH A MATERIAL THAT IS CAPABLE OF MAINTAINING THE FIRE RESISTANCE OF THE FIRE BARRIER OR BY AN APPROVED DEVICE WHICH SHALL MAINTAIN THE FIRE RESISTANCE OF THE FIRE BARRIER.
3. INSULATION AND COVERINGS FOR PIPES AND DUCTS SHALL NOT PASS THROUGH THE FIRE BARRIER UNLESS THE MATERIAL ARE CAPABLE OF MAINTAINING THE FIRE RESISTANCE OF THE FIRE BARRIER OR THE MATERIAL ARE PROTECTED BY AN APPROVED DEVICE THAT IS DESIGNED FOR THE SPECIFIC PURPOSE.
4. WHERE DESIGNS TAKE TRANSMISSION OF VIBRATION INTO CONSIDERATION, ANY VIBRATION ISOLATION SHALL BE MADE ON EITHER SIDE OF THE FIRE BARRIER OR IT SHALL BE MADE BY AN APPROVED DEVICE THAT IS DESIGNED FOR THE SPECIFIC PURPOSE.
5. CONCRETE, MORTAR, OR GROUT IS PERMITTED TO BE USED TO FILL THE ANNULAR SPACES AROUND IRON, STEEL, OR COPPER PIPE, AROUND TUBE OR CONDUIT, OR AROUND WIRES AND CABLES WITH STEEL JACKETS THAT PENETRATE CONCRETE OR MASONRY FIRE BARRIERS, PROVIDED THAT THE NOMINAL DIAMETER OF THE PENETRATING ITEM DOES NOT EXCEED 15.2 cm, AND THE OPENING SIZE DOES NOT EXCEED 929 cm². THE THICKNESS OF CONCRETE, MORTAR, OR GROUT SHOULD BE THE FULL THICKNESS OF THE BARRIER OR THE THICKNESS NECESSARY TO PROVIDE A FIRE RESISTANCE RATING NOT LESS THAN THE REQUIRED FIRE RESISTANCE RATING OF THE BARRIER PENETRATED.

6. AN APPROVED INTUMESCENT FIRE STOP MATERIAL IS REQUIRED AROUND uPVC AND HDPe PIPES THAT PASS THROUGH FIRE BARRIERS.

   EXCEPTION: FILLING OF ANNULAR SPACES AROUND uPVC AND HDPe PIPES PASSING FROM APARTMENT BATH ROOMS TO DUCTS, AND NOT CROSSING A FLOOR TO FLOOR BARRIER IN SO DOING, CAN BE TREATED AS PER ITEM 5 ABOVE, WITH THE ADDITIONAL MEASURE OF INSTALLING A 12mm X 12mm STRIP OF APPROVED INTUMESCENT FIRE STOPPING MATERIAL AT SAID POSITION.

7. THE FIRE BARRIERS DEFINED ARE AS FOLLOWS:

• FLOOR TO FLOOR	-	1 - HOUR
• SERVICE DUCTS	-	1 - HOUR
• PLANT ROOMS, SUBSTATION, LT PLANTS etc	-	2 - HOUR
• STANDBY GENERATOR ROO	-	2 - HOUR
• VERTICAL PARTITIONING/ FLOOR	-	1 - HOUR
• PARKING GARAGE SEPARATION	-	2 - HOUR
• EXIT ENCLOSURES	-	2 - HOUR
• ELEVATOR ENCLOSURES	-	2 - HOUR
• SERVER ROOMS	-	2 - HOUR
• KITCHENS	-	1 - HOUR
• RUBBISH ROOM	-	1 - HOUR

C **PLANT ROOMS**

1. ENCLOSURES TO PLANT ROOMS ARE TO BE TWO HOUR FIRE RATED WHERE A VERTICAL DUCT OF MORE THAN FOUR STOREYS HIGH LEADS OUT OF OR TO THE PLANT ROOM. A/C DUCTS ARE TO BE FITTED WITH FIRE DAMPERS AT ANY POSITION WHERE THEY PASS THROUGH THIS ENCLOSURE.

   EXCEPTION: IF THE VERTICAL DUCT OF MORE THAN FOUR STOREYS (TWO HOUR FIRE RATED) IS SEPARATED FROM THE PLANT ROOM WITH A TWO HOUR FIRE BARRIER AND ANY A/C DUCT THAT PASSES THROUGH THIS BARRIER IS FITTED WITH A FIRE DAMPER, THEN THE ENCLOSURE NEEDS BE ONE HOUR FIRE RATED, AND NO FIRE DAMPERS ARE REQUIRED FOR DUCTS PASSING THROUGH THE HORIZONTAL ONE HOUR RATED ENCLOSURE.

2. IN GENERAL FIRE DAMPERS TO A/C DUCTS ARE ONLY REQUIRED WHERE PASSING THROUGH FIRE SEPERATING AND DIVISION ELEMENTS.

   EXCEPTION: ANY AIR TRANSFER OPENING THROUGH ANY FIRE RATED CONSTRUCTION, FOR EXAMPLE A LOUVRE DOOR, MUST BE FITTED WITH A FIRE DAMPER/ FIRE SHUTTERS.

3. FIRE DAMPERS TO BE INSTALLED IN ACCORDANCE WITH THE REQUIREMENTS OF BS 9999 AND REFERENCED SPECIFICATIONS.

D **PENETRATIONS - SMOKE BARRIERS**

1. ALL OPENINGS, PIPES, CONDUITS, BUS DUCTS, CABLES, WIRES, AIR DUCTS, PNEUMATIC TUBES AND DUCTS, AND SIMILAR BUILDING SERVICE EQUIPMENT PENETRATIONS THAT PASSES THROUGH A SMOKE PARTITION SHALL BE PROTECTED BY FILLING THE SPACE BETWEEN THE PENETRATING ITEM AND THE SMOKE PARTITION, BY MEANS OF A MATERIAL THAT IS CAPABLE OF LIMITING THE TRANSFER OF SMOKE OR BY AN APPROVED DEVICE WHICH ARE DESIGNED FOR THE SPECIFIC PURPOSE.
2. WHERE THE PENETRATING ITEM USES A SLEEVE TO PENETRATE THE SMOKE BARRIER, THE SLEEVE SHALL BE SOLIDLY SET IN THE SMOKE BARRIER, AND THE SPACE BETWEEN THE ITEM AND THE SLEEVE SHALL BE FILLED WITH A MATERIAL THAT IS CAPABLE OF LIMITING THE TRANSFER OF SMOKE OR BY AN APPROVED DEVICE WHICH ARE DESIGNED FOR THE SPECIFIC PURPOSE.
3. WHERE DESIGN TAKE TRANSMISSION OF VIBRATION INTO CONSIDERATION, ANY VIBRATION ISOLATION SHALL BE MADE ON EITHER SIDE OF THE SMOKE BARRIER OR IT SHALL BE MADE BY AN APPROVED DEVICE THAT IS DESIGNED FOR THE SPECIFIC PURPOSE.
4. OPENINGS LOCATED AT POINTS WHERE SMOKE PARTITIONS MEET THE OUTSIDE WALLS, OTHER SMOKE PARTITIONS, SMOKE BARRIERS, OR FIRE BARRIERS OF A BUILDING SHALL BE FILLED WITH A MATERIAL THAT IS CAPABLE OF LIMITING THE TRANSFER OF SMOKE OR THEY SHALL BE MADE BY AN APPROVED DEVICE THAT IS DESIGNED FOR THE SPECIFIC PURPOSE.

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ANNEXURE E

AC MITIGATION INFRASTRUCTURE SPECIFICATION

[redacted]

PARTICULAR SPECIFICATION
P ACIM : AC INTERFERENCE MITIGATION

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[redacted]

PACIM 1 PURPOSE

This specification covers the requirements for the provision and installation of components and equipment required for AC interference mitigation.

The service to be rendered is the provision, installation, erection and commissioning of all the material and appurtenant works as required.

PACIM 2 GRADIENT CONTROL WIRE FOR GROUNDING

Gradient control wires or mitigation wires are typically installed parallel to the pipe as a grounding or earthing mechanism. These wires are also referred to as ribbons. The gradient control wires are generally installed for the following two main reasons: (i) to provide an earthing point which grounds induced pipeline currents and reduces the overall pipeline voltage,(ii) to reduce the coating stress voltages and touch voltages in their vicinity by changing the potential of the soil around the pipeline (ground potential rise or GPR).

In the case of one ribbon placed parallel to the pipe, it would generally be placed on the side closest to the overhead powerlines and at the invert level of the pipe. The second ribbon would be placed on the opposite side of the pipe. The gradient control wires should have a minimum separation distance to the pipeline of 200 mm. These ribbons are connected to the pipe using a cable, either directly or through a DC decoupling device.

If the zinc wires are to be installed in discrete sections, it would generally be limited to 400 m in length with the connection to the pipe made in the middle of such a section. In such a case the ends of consecutive sections must be more than 1 m from one another.

Gradient control wires shall be zinc ribbon. The composition of the zinc shall be as per STM B418 -95 – Type II, and suitable independent compositional testing shall be carried out by an accredited laboratory, in addition to the quality control information presented by the supplier of the zinc wire.

The zinc wire geometry and specification shall at least adhere to the following:

Aspect	0.893 kg/m Ribbon	1.785 kg/m Ribbon
Zinc weight	0.893 kg/m	1.785 kg/m
Cross section (D1 x D2)	12.7 mm x 14.3 mm	22.2 mm x 15.8 mm
Radii (R1 x R2)	2 mm x 5 mm	2 mm x 5 mm
Wire diameter	≥ 3.3 mm	≥ 3.4 mm
Potential	-1.1 V_{CSE}	-1.1 V_{CSE}

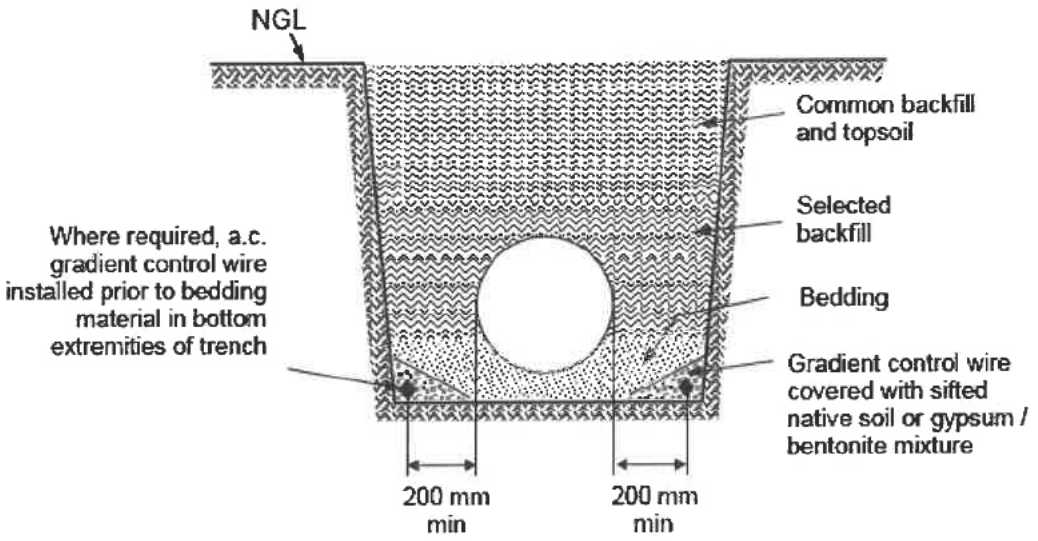
The zinc wire, where required, shall be installed in the corners of the trench prior to bedding material. Fig 1 shows a typical section of the trench with two gradient wires. In the case of a single gradient wire, the wire shall be installed in the corner of the trench closest to the overhead powerline.

[redacted]

The jointing of the zinc wire shall be made by exposing the steel core wire and jointing this with a hex ferrule with silver solder. The exposed wire jointed part is then then encapsulated with zinc (10 mm minimum cover) by casting this around the joint.

The gradient wire shall be covered with either native soil (sifted if necessary) or with a gypsum/ bentonite mixture, prior to the bedding material.

Fig 1: Typical Pipe Trench With Gradient Control Wire



PACIM 3 LUMPED GROUNDING MAT

Lumped grounding or earthing is often required as an additional mitigation measure or as a measure on its own. The gradient control wires are generally installed for the following two main reasons: (i) to provide an earthing point which earths induced pipeline currents and reduces the overall pipeline voltage,(ii) to reduce the coating stress voltages and touch voltages in their vicinity by changing the potential of the soil around the pipeline (ground potential rise or GPR).

Lumped grounding (earthing) shall be by means of a mat constructed from zinc wire. The mat is to be made up by affixing the zinc wires at right angles to form a square followed by further zinc wires inside this square to form blocks. The dimensions of the square and the spacing of the internal wires shall be in accordance with the specifications and the drawings. At each wire cross point the steel wire core is to be exposed and the steel wire is to be spot welded to one-another. The exposed wire jointed part is then then encapsulated with zinc (10 mm minimum cover) by casting this around the joint.

The grounding mat shall be zinc ribbon. The composition of the zinc shall be as per STM B418 -95 – Type II, and suitable independent compositional testing shall be carried out by an accredited laboratory, in addition to the quality control information presented by the supplier of the zinc wire.

[redacted]

The zinc wire geometry shall at least adhere to the following:

- Cross section (D1 x D2) : 12.7 mm x 14.3 mm
- Radii (R1 x R2) : 2 mm x 5 mm
- Zinc weight : 0.893 kg/m
- Wire diameter : 3.3 mm
- Potential : -1.1 V_{CSE}

Such a grounding mat would generally be placed on the side closest to the overhead powerlines and not more than 900mm below finished ground level. The zinc mat would be connected to the pipe by means of two cables, either directly or through a DC decoupling device.

The zinc mat shall be of overall dimension as specified and manufactured with the zinc ribbon spacing as provided in Table 3.1.

Table 3.1: Zinc Mat Arrangement

OVERALL PARALLEL DIMENSION	OVERALL PERPENDICULAR DIMENSION	A	B	C	D	E	E	D	C	B	A
		mm									
1.5 m	1.5 m	200	300	250					250	300	200
3.0 m	3.0 m	200	300	550	450			450	550	300	200
6.0 m	6.0 m	250	400	550	800	1000	1000	800	550	400	250

PACIM 4 RESISTANCE REDUCING CHEMICAL BACKFILL MATERIAL

The main purpose for a selected chemical backfill around the earthing or grounding material (zinc or other material) is to lower the resistance of the anode to the surrounding soil and to improve electrical conductivity. This selected backfill would also assist in providing a uniform environment around the anode to allow it to corrode uniformly to ensure continuous effective operation and would help to maintain a moist environment.

A selected chemical backfill material that is deemed suitable, is a mixture of:

- a suitable bentonite clay for moisture retention with low swelling potential
- a gypsum material (agricultural gypsum) which improves the quality and the electrical conductivity

A graded backfill is required (it should not consist of fines only) to facilitate wetting of the backfill. Table 4.1 provides the particle size distribution requirement.

Table 4.1: Particle Size Distribution for Gypsum and Bentonite Mixture

Sieve Mesh Size (µm)	Distribution as % Passed
1000	100
600	90
150	70
45	30

[redacted]

The selected backfill composition is to be as specified in Table 4.2. These backfills are usually for grounding materials consisting primarily of Zinc and Magnesium.

Table 4.2: Selected Backfill Types

	Designation Type (By mass)			
Material	**B1.1**	**B1.2**	**B2**	**B3**
Gypsum ($CaSO_4.2H_2O$)	50%	75%	40%	50%
Calcium Bentonite	50%	20%	-	45%
Sodium Bentonite	-	-	60%	-
Sodium Sulphate (Anhydrous)	-	5%	-	5%

Typical use of Type of Backfill:	
Type B1.1:	• Generally for Zinc grounding rod/wire • General use • Little swelling is expected when wetted (about 25% from dry to wet) • Expected resistivity when wet = 3 to 6 Ω.m
Type B1.2	• Generally for Magnesium grounding rod/wire • Little swelling is expected when wetted
Type B2:	• For areas with permanent water table • Swells greatly when wetted (about 600% from dry to wet) and shrinks greatly when drying • Expected resistivity when wet = 1 to 4 Ω.m (wetted)
Type B3:	• Where improved water permeability is required • Not for areas with permanent water table

The Type description and naming are the same as the Australian Standard As-2239-2003 titled "Galvanic (sacrificial) Anodes for Cathodic Protection", excepting for the division of the B1 type into a B1.1 and a B1.2 type.

Selected backfills shall be well compacted around the anode and dampened down, when necessary, by liberal application of water, before completing the total backfilling of the excavation. The backfill material must be protected from moisture after mixing so that lumps are not formed. The installed dimensions to be at least those specified, with the earthing rod placed in the middle of the backfill. If no dimensions are provided, a cover of at least 80 mm is required.

PACIM 5 DC DECOUPLER FOR ZINC RIBBON AND LUMPED ZINC GROUNDING MAT

For pipelines equipped with Impressed Current Cathodic Protection (ICCP) systems, the grounding (earthing) system that is achieved by zinc material shall not be connected to the pipeline directly but only through a solid state DC decoupling device. Such a device shall be housed in a valve chamber, pre-cast concrete bunker or a dedicated enclosed AC mitigation station. The device shall be certified by a suitably accredited test laboratory to meet the specifications given in Table 4.1

Table 5.1: Performance Specification for DC Decoupling Device for Gradient Control Wire (Ribbon) and Lumped Grounding Mat

Specification /Test	Level /Requirement	Comment
Class 1 impulse current rating	10 kA., 10/350 µsec	to SANS 61643-1 requirement
Front of wave spark-over voltage	≤ 500 V, 1.2/50 µsec	to SANS 61643-1 requirement
Rated AC short circuit	3.7 kA r.m.s., 1 sec, 50 Hz	to SANS 61643-1 requirement
Rated AC load current	45 A r.m.s., 50 Hz, max temp incr. 40° C	at maximum DC blocking voltage, to SANS 61643-1 requirement
AC impedance at 50 Hz	≤ 0.04 Ohm	at rated load current
DC blocking voltage	-3 V/+1V(+/-10%)	if influenced by spurious DC. (railway, anode ground bed), reduce to -12V/+1V
DC. leakage (blocked)	≤ 1 mA	at AC load thermal limit
DC current withstand	10 A for 15 mins	without overheating, test in both directions
Housing dielectric withstand voltage	5.8 kV	to SANS 61643-1 requirement
Environmental, enclosure	IP55	adjust upwards for more extreme environments
Ambient temperature range	-15° C to 60° C	
Air clearance and creepage distances	10 mm and 15 mm min respectively	to SANS 61643-1 requirement
Protection against direct contact	no direct contact	Using IEC60529 test finger
Basic insulation level required	2 500 Vac	

Additional requirements for the DC. decoupling device are:

a) The decoupling device shall comprise a suitably rated diode stack capable of blocking direct current in both directions at the specified voltages.
b) The device shall exhibit a progressive, smooth transition from blocking to conduction to and vice versa without commutating.
c) A bypass capacitor (network) shall be connected in parallel with the diode stack to conduct 50Hz AC up to the blocking voltage of the diode stack.
d) The capacitor (network) shall be protected by a suitably rated surge protection device (SPD) for high voltage and lightning-induced transients. The SPD shall be decoupled from the capacitor and diode network with the appropriate inductance, in accordance with SANS 61312-3. This inductance shall remain effective (i.e. not saturated) during simultaneous transient and maximum DC. current conditions.
e) The decoupling device shall preferably be of open frame construction to permit maintenance and replacement of component parts. The frame shall be sized to fit on a standard 800 mm x 600 mm chassis plate.

f) The decoupling device shall be provided with two M10 terminals at each installation point for the connection of 25 mm² single core cables.
g) If housed in a location classified as hazardous in SANS 10108 and ARP0108, for example in case of gas or fuel pipelines, the decoupling device shall be explosion proof (Ex-rated). The nature of the classification study in accordance with SANS 10108.

The housing for the components shall be supplied with a danger warning sign for High Voltage at an obvious place on the unit.

PACIM 6 EQUIPOTENTIAL APRON (MATS) / PLANE

Equipotential aprons or mats are required at all locations of the exposed pipeline appurtenances (eg valve chambers, test posts, structures in contact with pipe, structures housing components that are connected to the pipe) on the pipeline sections where specified.

Equipotential aprons may be implemented with zinc ribbon or with steel weld mesh mats.

Zinc ribbon arrangement shall only be allowed where specified in the project specification. The zinc wire shall have the same specification as the lumped grounding mat wire specified in section PCAIM 2 above.

Steel weld mesh installation at chambers or bunkers (or structures) shall be as follows:

a) The conductive concrete apron is usually placed on the finished ground level around the structure (or buried at a depth as shown on the drawings). The apron shall only be placed on firm undisturbed ground or a compacted prepared base. The dimension of the concrete apron shall be at least 1.2 m from any part of the structure.
b) A 200 mm x 200 mm reinforcing steel weld mesh of 8 mm diameter (Y8) steel wire (not galvanized) mesh ref number 395 extending 1.2 m beyond the external wall of the chamber.
c) All overlaps shall be 200 mm minimum joined by welding at least every 400 mm to form an electrically continuous system.
d) For circular chambers the weld mesh shall be two overlapping panels with a circular cut-out to achieve a 1.2 m distance from side of the chamber – the mesh may be cut square if preferred on condition that the minimum distance of 1.2 m is achieved.
e) The weld mesh is centrally located in a 100 mm thick Class 15/19 MPa conductive concrete slab. The concrete is deemed conductive when at least 1/3rd of the sand that would normally have been used in the mixture is replaced with coke breeze (see specification in this specification).
f) The mesh panels are connected to the pipeline with one or two cables through a decoupling device and the cables be kept as short as possible (≤ 1.5 m).
g) Continuity in a reinforced steel concrete structure relies on the interconnection of the re-bar (reinforcing). The reinforcing is then equipped with at least two (2) connector plates (5 mm thick steel with a 10 mm hole for cable connection) which are welded to the mesh protruding through the wall at suitable positions. The

connector plates are connected to the pipeline with a cable through a voltage limiting device and the cables kept as short as possible (≤ 1.2 m).

h) The inclusion of a weld mesh layer cut to the floor size above a mass concrete floor/base in a screed (typically the sloping screed added for positive drainage on a chamber floor. The reinforcing is then equipped with at least two (2) connector plates (5 mm thick steel with a 10 mm hole for cable connection) which is welded to the mesh protruding through the screed at a suitable position. The connector plates are connected to the pipeline with a cable through a voltage limiting device and the cables kept as short as possible (≤ 1.5 m).

i) For air valves using pre-cast concrete rings as walls, the steel reinforcing is generally inaccessible and only the reinforcing in the concrete floor (or a screed in the floor has no rebar) is connected to the pipeline.

The external equipotential mat may be replaced by external asphalt cover only if the project specification allows for it. The installation requirements for an external asphalt cover is:

a) Compact soil and install asphalt cover of 100 mm or thicker, extending to 1.5 m around the chamber, suitably sloped for surface water dispersion away from chamber (2% slope min),

b) Use a 500 µm thick PVC sheet below asphalt to prevent weed growth through cracks

c) Install a weld mesh cut-out on chamber floor as described in the previous paragraph.

PACIM 7 COKE BREEZE FOR CONCRETE CONDUCTIVE SCREED

The use of Sasol Corr-Carb pitch coke is preferred for coke breeze. The chemical composition is as follows:

Element/Compound	Specification	Test Method
Fixed Carbon	99.5%min	By calculation – 100% minus (%ash + VCM)
Sulphur	0.25% max	ASTM D 4239
Ash & volatiles	0.50% max	Ash – ASTM D 4422 Volatiles – BS 1016: Part 4
Moisture	0.15% max	ASTM D 3173
Bulk density	1000 kg/m^3 max	ASTM D 527
Resistivity	55 Ωm max	Alusuisse C - 109

The particle size distribution (calculated as per ASTM D 293) shall be a maximum of 100% < 1.0 mm and a minimum of 5% < 0.5 mm.

PACIM 8 DECOUPLER FOR EQUIPOTENTIAL APRON / MAT / PLANE

Pipelines equipped with a Cathodic Protection system shall not be connected to the pipeline directly but only through a suitable decoupling device. Such a device shall be housed in a valve chamber or a dedicated enclosed AC mitigation station. The device shall be certified by a suitably accredited test laboratory to meet the specifications given in Table 8.1

Table 8.1: Performance Specification for Decoupling Device for Equipotential Mats or Steel Reinforcing of a Concrete Structure

Specification / Test	Level / Requirement	Comment
Nominal impulse discharge current rating	10 kA., 8/20 µsec wave form	to SANS 61643-1 requirement
Voltage protection level	≤ 400 V	to SANS 61643-1 requirement
Response time	≤ 25 nsec	
Short circuit withstand	3.7 kA r.m.s., 1 sec, 50 Hz	to SANS 61643-1 requirement
Housing dielectric withstand voltage	5.8 kV	to SANS 61643-1 requirement
Maximum continuous AC operating voltage	75 Vr.m.s. (+/-10%)	
Maximum continuous DC operating voltage	100 V (+/-10%)	
Operating state / Fault indication	Green / Red	Mechanical switch
Environmental enclosure	IP55	Adjust upwards for more extreme environments
Ambient Temperature	-15° C to 60° C	
Air clearance and creepage distances	10 mm, 40 mm respectively	to SANS 61643-1 requirement
Protection against direct contact	IP4X	Using IEC 60529 test finger

The housing for the components shall be supplied with a danger warning sign for High Voltage at an obvious place on the unit.

If housed in a location classified as hazardous in SANS 10108 and ARP 0108, for example in case of gas or fuel pipelines, the housing for the voltage limiting device shall be explosion proof (Ex- rated). The nature of the Ex-rating required and the applicable test standard shall be determined by a specialist following a classification study in accordance with SANS 10108.

PACIM 9 CABLING

In general all connections of decoupling devices to the pipeline, zinc gradient control wire and equipotential apron / mat / structure reinforcing, are to be made with single core multi-strand copper cables. Other cable connections generally also single core (unless otherwise specified), multi-strand copper cables insulated as specified. All cables are to be multi-strand copper cables which are insulated as specified and rated for voltages up to 600 V / 1 000 V (unless required otherwise as a special requirement).

The stranding shall be in accordance with SANS 1507 or ASTM B-B. In places where cable theft is a problem, the copper cable can be replaced with an equivalent sized composite stranded cable made up of tinned copper wires and galvanised steel wires that are braided-interwoven to form the cable.

[redacted]

Table 9.1: Cable specification (unless specified otherwise in the drawings)

Purpose	Size (mm^2)	Insulation	Colour
Pipe to VLD/SPD in chamber/bunker	25	PVC/PVC	Black
Pipe to DC decoupler in chamber/ bunker	25	PVC/PVC	Black
Pipe to a link coupling for monitoring in chamber/bunker	16	PVC/PVC	Black
Pipe to chamber/bunker in ground for monitoring or coupons	16	XLPE/PVC	Black
Pipe to chamber/bunker in ground for VLD/SPD	25	XLPE/PVC	Black
Pipe to chamber/bunker in ground for DC decoupler	25	XLPE/PVC	Black
AC Coupon to link coupling in chamber/ bunker	Two Core 6	PVC	Blue
Grounding wire (ribbon)	25	PVC/PVC	Yellow /Green
Grounding to mat/apron/chamber mesh	25	PVC/PVC	Yellow /Green
Continuity bonding in chamber	25	PVC/PVC	Black
Cross bonding and continuity bonding in soil around a structure	2x 25	PVC/PVC	Black
Continuity bonding in soil around a flange	2x 5mm thick steel flat welded to flange	Encapsulate with bituminous product	N/A

The detailed requirement for doubling the cable for redundancy would be project specific.

The cable to zinc connections shall comprise of suitably sized hex ferrule crimping the cable connection to the anode core wire of the zinc ribbon, silver soldering. The whole joint and an overlapping section past the jointed area shall be encapsulated with an approved self-vulcanizing butyl rubber tape or a heat shrink mastic lined tube with a 2.5 mm after recovery thickness.

The cable to zinc connections shall comprise a suitably sized hex ferrule crimping of the cable to the exposed steel core wire of the zinc ribbon, silver soldering the joint area and encapsulating the entire joint in a mastic lined heat sleeve of suitable diameter resulting in a 2.5 mm insulated recovered thickness.

Splicing of cables underground shall be avoided. However, should splicing be required, a suitable compression fitting and press tool shall be used or alternatively a line tap if an additional cable is to join the main cable. The connections are to be waterproof epoxy filled splicing kits. The cable insulation is to be roughened with 160 grit sand paper before the epoxy is poured into the mould. The epoxy is to completely cover the exposed cable and jointing material and shall fill the mould completely. Sufficient time must be allowed for the epoxy to set (as per manufacturer's instructions) before the joint is buried. The epoxy splicing kit may not be used if the expiry date has passed.

[redacted]

Lug connections shall be made with heavy duty copper with electroplated tin connector lugs of appropriate size. A heat shrink sleeve shall be provided to seal off the break in insulation and the lug and this sleeve is to protrude sufficiently past this point to make a waterproof seal.

Cable markings shall be one of the following types:

- Snap-on plastic marker of suitable size with engraved black lettering on yellow background
- Stainless steel strip tape with information punched in (minimum letter height 4.5mm) with metal fixing ties
- Adhesive label covered with transparent heat shrink sleeve.

PACIM 10 CABLING CONNECTION TO STEEL PIPE

10.1 General

A suitable method to secure cables to pipes is required to allow for continuity bonding, cross bonding, pipe to test post connections, CP, ACIM component connections to be made.

The connection of a cable to the steel pipe is preferably made at any thicker part available at the jointing locality – such a thicker part be a pad specifically provided for this purpose, the socket of an insert type connection, a flange, or any other suitable thicker material part.

Cable connection establishment on thin walled pipes (less than 8 mm thick) or pipes lined with epoxy or polyurethane requiring any form of heat must be made with the pipes full of water. Any such welding must be preceded with by a trial on a spare pipe and the lining subjected to a holiday detection test (spark test) before and after the attachment.

A detailed procedure for any proposed cable connection to pipe is required after successful trials have been made and a proposed cable connection method is established.

Thermit welding is the preferred method should it comply with the requirements. Stud welding is the preferred method of cable attachment on thinned wall p[pipes (ie wall thickness less than 8 mm).

10.2 Thermit Welding

As far as possible, cables are to be connected to the pipe barrel at a field joint prior to field joint repair and coating make good or at a flange.

The area where thermit welding is to take place shall be thoroughly cleaned to provide an area approximately 75mm x 75mm. All traces of petroleum mastic, concrete, pipeline coating, primer material or any other matter must be removed and the surface is to be brushed with a steel wire brush. Prior to making the weld the area must be roughened using a coarse file or an angle grinder, and preheated with a portable gas torch.

[redacted]

The end of the insulated cable must be made bare for at least 25mm. A retaining cap in the bottom of the mould is placed and the weld powder is poured into the mould. The weld is covered with the starting powder. The cable is then placed on the pipe and the mould squarely over the cable, pressing it down firmly. The lid is closed, the starting powder is ignited with a flint gun which allows the weld to solidify. The mould is removed and the residue is cleaned out in preparation for the next weld.

After the above procedure has been carried out, the weld shall be tested by tapping the weld with a 2kg hammer. Should any movement occur the cable shall be re-welded and re-tested.

10.3 Stud Welding

Remove section of pipe coating using a portable sanding device. Remove all traces of dirt and degrease.

The weld gun must be manually loaded with an appropriately designed stud and pressed onto the pipe surface in such a way that the supporting feet touch the surface of the pipe. The welding process is initiated by actuating the start button. Against the force of the pressure spring, the gun coil lifts the lifting mechanism with the welding stud off the surface of the pipe by the set gap distance. The power thyristor of the welding unit is triggered. The gun coil is switched off-circuit so that the stud is accelerated back onto the pipe surface by means of the pre-tensed pressure spring. As soon as the ignition tip of the stud touches the surface of the pipe, the welding circuit is closed. The high capacitor discharge current of the welding unit has the effect that the ignition tip of the stud partially evaporates. In so doing, the ignition gap between the surface of the pipe and the stud is ionised and welding arc is ignited.

As a result of the heat charge of the welding arc, the fore-part of the stud and an area of the pipe surface of approximately the same size melt so that a pool of molten mass forms on the areas to be welded. When the stud makes contact with the surface of the pipe, the arc goes out. Before the molten mass hardens the stud is pressed by the force of the spring. The remaining energy of the capacitor battery is discharged in a short circuit. The weld gun can then be removed from the welding stud immediately afterwards.

Connect the lugged cable to pipe using stud welder.

10.4 Pin Brazing

The technique used shall ensure that metallurgical contact is achieved between the cable and the pipe. Details of the equipment to be used must be submitted to the Engineer before being applied.

The minimum area of coating shall be removed. After connecting the cable the entire exposed area shall be encapsulated in epoxy. The procedure for this is as follows:

- Clean the remaining coating to at least 50mm beyond the final repair limits.
- Construct a dam from a suitable material around the coating repair area.
- Apply 2 component (squish pack) over the repair area, ensuring a minimum 5mm cover over the cable connection (for epoxy coating a Hi-Cote 151E epoxy or

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equivalent). A minimum overlap of 50mm shall be made over the existing coating.

10.5 Making Good of the Coating System

All coating repairs at cable connections shall be made in accordance with the repair procedures relevant to the coating system applied to the pipe.

If cables are attached to the barrel of the pipe, these attachments should be made at field joints to minimise the number of repairs required. If the pipe is epoxy lined, then repairs will also be required to the internal lining.

Any attachments to the barrel of the pipe which are buried, will require repair using circumferential wrapping. Patch repairs may not be used in buried applications.

Cable connections to epoxy or [polyurethane coated fitting in valve chambers shall be encapsulated with a heat applied bituminous patch.

PACIM 11 INSULATING FLANGES (IF)

11.1 Materials

An insulating flange kit consists of an insulating gasket, bolt sleeves and washers, appropriately sized steel bolts and nuts and washers and a voltage limiting spark gap for protection of the insulating materials.

All data sheets of IF`s are to be submitted to the Engineer for approval prior to installation.

Insulating sleeve shall be a minimum 1mm thick glass fibre reinforced polyester sleeve for each bolt. The total length of sleeves is to be 2-3mm less than the length between inside faces of steel washers. The insulating sleeves shall fit completely inside the insulating washers.

Insulating washers shall be 3.2mm thick fabric reinforced phenolic resin with an outer diameter the same as that of machined steel washer, 2 off for each stud bolt. The internal diameter to be a sliding fit over the outer diameter insulating sleeve. Steel washers shall be machined with diameter and thickness to SANS 1700. Stud bolts and studs shall be grade 8.8 and nuts grade 8 to SANS 1700 (unless the specified bolts and nuts for the project being of a different grade, then that grade shall apply). Stud bolt diameters shall be selected to the next smaller size for installation in standard drilled flanges. Stud bodies shall be machined down to the next smaller standard size and suitable smaller nut to be used.

Explosion-proof Spark Gap Type Dehn EXFS L (or similar approved) with a power frequency sparkover voltage rating of at least 1.2 kV shall be installed across the flange faces complete with hot-dip galvanised mild steel mounting brackets to suit the flange bolt, as supplied by Surge Technology (RSA), or similar approved. The width of the holding bracket of the explosion-proof spark gap shall be the same as the steel and insulation washers and the bottom end are rounded off to fit into the spot faced area of the valve and/or steel flange.

11.2 Installation and Testing Of Insulating Flange

Insulating joints are to be housed in a well-drained and ventilated chamber with inspection access. The following types are to be specified:

- Type 1 insulating joints shall be hydraulic tested in the factory to 1.25 times the flange classification.
- Type 2 insulating joints shall not leak at field test pressure.

After installation, the insulating joints must be inspected to ensure their compliance with the
specifications and drawings and tested for satisfactory electrical insulation. The inspection shall be witnessed by the Employer, the designer of the ACIM installation and the Contractor.

A radio high frequency tester can be used to test the insulation of the joint. The test shall be performed on each side of the flange as well as on each bolt-nut set individually.

Alternatively, the following tests can be carried out for electrical testing of the insulating flange:

1 A free-floating compass shall be placed on top of the insulating flange. The needle normally aligns itself along the pipeline axis. If strong stray currents are present the needle may align at an angle to the pipeline

2 A 12 Volt heavy-duty car battery or DC welding generator should then be used to bridge this insulating flange. If the insulating flange is functioning correctly, no significant deflection of the needle will be observed. If the insulating flange is not functioning, the compass needle will deflect to a position orthogonal to the pipeline.

3 The current drawn from the battery is an additional indicator of flange integrity. A short circuited IF will typically draw in excess of 200A before changing a faulty insulating flange assembly, a bolt by bolt continuity check should be carried out to determine if the problem is not a faulty bolt, isolating sleeve or isolating washer.

Re-testing must be carried out upon replacing any faulty component.

11.3 Identification and Tape Wrapping Of Insulating Flange

The entire insulating flange must be wrapped circumferentially with a white plastic backed polymer modified bituminous tape, or similar approved, 1,5 to 2,0mm thick with a minimum 25mm overlap.

In case of surface irregularities, i.e. stepped flanges, etc., an approved mastic material shall be used to provide a smooth contour for subsequent tape application.

A metal tag shall be attached via a 1mm stainless steel locking wire through a 2mm hole drilled in the tag and in the most overt insulating flange bolt. The following is to be stamped on the metal tag:

"OPERATING INSULATING FLANGE"

A 25mm wide plastic backed electrical tape (SANS 122-1975) coloured red shall be applied in the centre on the horizontal surface.

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