O. R. TAMBO DISTRICT MUNICIPALITY

O.R. TAMBO
DISTRICT MUNICIPALITY

PROJECT NUMBER: MIS 361 188 A

DESCRIPTION: LIBODE WASTEWATER TREATMENT WORKS AND SEWER RETICULATION PROJECT PHASE 2: COMPLETION OF A WASTEWATER TREATMENT WORKS

CONTRACT 1

VOLUME 2

JANUARY 2025

NAME OF BIDDER:	
BID AMOUNT:	**SEE VOLUME 1**
CSD SUPPLIER NUMBER:	
CLOSING DATE & TIME:	**10 MARCH 2025 @12H00**

Prepared for:
The Municipal Manager
O. R. Tambo District Municipality
Private Bag X6043
MTHATHA
5099

Tel. No. (047) 501 6400

Prepared by:
The Infrastructure Water and Sanitation Services
O. R. Tambo District Municipality
Private Bag X6043
MTHATHA
5099

Tel. No. (047) 501 6425

- INDEX -

PART C3: SCOPE OF WORK

O. R. TAMBO DISTRICT MUNICIPALITY

CONTRACT NUMBER: MIS 361 188 A

LIBODE WASTEWATER TREATMENT WORKS AND SEWER RETICULATION PROJECT PHASE 2: COMPLETION OF A WASTEWATER TREATMENT WORKS

CONTRACT 1

C3.1. DESCRIPTION OF THE WORKS

STATUS

In the event of any discrepancy between the Scope of Work and any part of the SANS 1200 Standardized Specifications, the Bill of Quantities or the Drawings, the Scope of Work shall take precedence and prevail in the Contract.

C3.1.1 Employer's Objectives

The objective of the Employer (O. R. TAMBO DISTRICT MUNICIPALITY) is to provide a long-term reliable and adequate Wastewater Treatment facility to serve the town of Libode to alleviate the current wastewater disposal challenges facing the town.

Phase 2 is an extension of Phase 1which was not completed due to funding challenges.

C3.1.2 Overview of the Works

This contract entails the construction of a Wastewater Treatment Works in Ward 7

C3.1.3 Extent of the Works

The Scope of Work envisaged to be carried out under this Contract is summarized as follows:

Civil Works

- Remedial Works at the WWTW from Phase 1 which includes repair of honey coming of all concrete structures that have been constructed, backfilling of unstable structures, repair of exposed rebar on concrete structures and water tightness testing and water proofing. The structures included in these remedial works are the following.

  - 2 x Intermediate Settling Tank Bridges, repair of honey coming
  - Supernatant Pumpstation
  - Chlorine Contact Tank
  - Recirculation Pumpstation Building
  - Sludge Drying Beds
- Construction of a Sewer Pump Station and Guardhouse close to the police station in town
- Construction of Inlet Works Building Shed
- Construction of two 12.5m diameter Concrete Biofilters Units.
- Construction one 3 600m^2 area Sludge Lagoon
- Construction one 3 600m^2 area Maturation Pond
- Construction one 3 600m^2 area Reedbed
- Interconnecting Pipework
- Subsurface Drainage
- Fencing at The Treatment Plant, Sewer Pumpstation and at the Staff Houses
- Construction of Two 2-bedroomed Staff Houses
- Construction of a Guardhouse at the WWTW
- Construction of Main Access Road to the WWTW
- Construction of Internal Site Access Roads and Parking at the WWTW
- Drilling of Monitoring Boreholes x 2
- Construction of Administration Building
- Construction of Control Room and Generator Building
- Construction of a Chlorine Building
- Water Reticulation at the WWTW
- Sewer Reticulation at the WWTW

Mechanical Works

The scope of works for the mechanical installation includes the detailed design, supply, delivery, installation, testing, commissioning, operating manuals, upholding during the trial operation period and the defects notification period of the following but not limited to the following equipment:

- All equipment at the inlet works consisting of but not limited to the following:
- Six hand sluice gates
- One manually raked coarse screen
- One hand raked emergency bypass screen
- 3 Waste skips
- Parshall Flume

- All equipment for the 2 Biological Filters consisting of but not limited to the following:
- Biofilter Media
- Weir Plates
- Desludge Valves
- All equipment in clarifier division box consisting of but not limited to the following:
- Weir plates
- isolating gates
- All equipment in two new final clarifiers consisting of but not limited to the following:
- Scum removal system
- Scum baffles
- Weir plates
- All equipment in a new gaseous chlorination facility including but not limited to the following:
- Motive water pumps inclusive of pipe, fittings and valves
- Ejector
- Chlorinator
- Gas flow measurement
- Scales
- Manifold
- Chlorine scrabbing system
- Diffuser
- Extraction fan
- Pumps including all pipes, fittings and valves davits and lifting where required consisting of but not limited to the following installations:
    - Two (duty/standby) Raw Sewage Submersible Pumps at the Sewage Pumpstation close to the Police Station
    - Two (duty/standby) Recirculation Pumps (2 sets)
    - Two (duty/standby) dry mounted service water pumps
    - Two (duty/standby) submersible sludge pond pumps

Electrical Works

The scope of works for the electrical installation entails the design, supply, delivery, installation, testing, commissioning and upholding during the trial operation period and the defects notification period of the following equipment and materials:

- Main incoming power cables to the Wastewater Treatment Works' transformer.
- Transformer.
- Two standby diesel generators complete with LV control panel, day tank, fuel lines and filters, inlet/outlet sound attenuation, including mains supply monitoring and automatic changeover panel

- One low voltage motor control centre (MCC).
- All low voltage power cables.
- Power cable supports and racking where applicable.
- Small power and lighting installations.
- Area lighting installation.
- Field control stations.
- Earthing of equipment and installation of an earthing system associated with the new buildings.
- Testing and commissioning of the electrical works.
- Operations and maintenance manuals.
- Training of municipal staff in the operation and maintenance of the electrical installation.
- Ground cable trenching (including danger tape and backfilling).
- Sealing of all cable ducts after the installation of the cables.

Electronic Works

The Scope of Works for the Electronic installation includes the detailed design, supply, delivery, installation, testing, commissioning, upholding during the trial operation period and the defects notification period of the following equipment and materials for the WWTW:

- A new, Programmable Logic Controller (PLC) System installed in the WWTW main, LV MCC
- A single, Human Machine Interface (HMI) at the main LV MCC
- A MCC tier, fully equipped for housing the PLC, UPS, network equipment, fibre optic distribution equipment and marshalling termination section at the rear for field instrumentation
- Distributed, PLC Remote I/O systems and panels
- Field Instrumentation
- Field Instrumentation enclosures
- Control and instrumentation cabling and cabling support infrastructure i.e. cable racks, trenches and conduits
- Network cabling and cabling support infrastructure i.e. cable racks trenches and conduits
- A centralised Uninterruptible Power Supply for the PLC, HMI, networking equipment and analytical field instrumentation as specified

General

- Subcontracting a minimum of 30% of the of value of work excluding manufacture of pipes, contingencies, and provisional sums to SMMEs as per the project specification.
- Dealing with community participation with regards to the construction.
- Environmental management of the area during and after the completion of construction.

- Compliance with the requirements of the Occupational Health & Safety Act of 1993, Construction Regulations 2014 and COVID-19 requirements.

This description of the Works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this Contract. Approximate quantities of each type of work are given in the Bill of Quantities.

C3.1.4 Location of the Works

The Project is located in O. R. Tambo District Municipality within Nyandeni Local Municipality (NLM),. The town of Libode is approximately 30km East of Mthatha on the R61 road from Mthatha to Port St Johns. Access to the site is via the tarred main road off the R61 Mthatha to Port St Johns Road. Once in Libode town, the site is accessed through crossing a low-lying bridge on the road to Bhekizulu Senior Secondary school. It should be noted that access is good all year round. The site generally drains towards northwards towards the existing stream. The location of the site is indicated on the locality plan bound as Appendix A.

The coordinates of the center of the site are as shown below.

Table 2-1: Project Locality

Name	Latitude (S)	Longitude (E)
Libode	31°32'30.61"S	29° 0'22.21"E

C3.1.5 Temporary Works

The Contractor will be responsible for determining the extent of temporary works required to execute the contract, and the cost thereof shall be included in the rates for the respective items of work. Nonetheless, it is envisaged that temporary work may be required for the following activities:

- Pipeline trenches requiring shoring due to space and depth constraints.
- Construction of pipelines near existing fences, which must be temporarily removed, will require the erection and maintenance of temporary fencing until restoration of the original fences.
- Construction of pipe trenches near existing properties or through existing accesses may require the provision of temporary access for pedestrians, livestock or vehicles.
- Traffic control measures where construction takes place at or close to existing roads.
- Safety measures deemed necessary by the Health and Safety specification or the Contractor’s own risk assessment (e.g. pedestrian barriers).

C3.1.6 Construction Programme

The programme of construction shall be submitted to the Employer’s Agent within the time stipulated in these documents. The programme shall clearly show all activities related to the works and shall indicate which activities are on the critical path.

In compiling the programme, the Contractor shall consider the following:

- The requirements and effects of employing labour-intensive construction methods.
- The lead-time for training of local labour.
- The accommodation and safeguarding of public access and traffic.
- Establishment and de-establishment times.
- Time to obtain all permits and wayleaves.
- Appointment of Community Liaison Officer (CLO).
- All public and Contractor close down periods.
- All other activities required in terms of this document.

If during the contract, the execution of the work deviates in any manner from the programme, the Contractor shall, on instruction by the Employer's Agent, within one week of such instruction submit a revised programme. Should such a revision be because of the Contractor falling behind with his work, the programme shall clearly show the steps to be taken to rectify the situation so as to enable the contract to be completed within the stipulated contract period. Positive steps to increase production through increased resources, or the more efficient usage of existing resources shall accompany such a programme. The tender programme shall however be used.

C3.2. ENGINEERING

C3.2.1 Design Services and Activity Matrix

Responsibilities for design and related documentation are as follows:

• Concept, feasibility and overall process	Employer
• Basic engineering and detail layouts to tender stage	Employer
• Final design to approved construction stage	Employer
• Temporary works	Contractor
• Preparation of record drawings and GIS information	Contractor/Employer

C3.2.2 Employer's Design

The Employer's design encompasses the permanent Works described in C.3.1.3 and what is included on the drawings.

C3.2.3 Design Brief

The design of the permanent Works is the responsibility of the Employer's Agent.

The Contractor is responsible for the design of the temporary Works required for the construction and execution of the permanent Works.

Where the Contractor is to supply the design of designated parts of the permanent Works or temporary Works, he shall supply full working drawings supported by a professional Employer's Agent's design certificate.

C3.2.4 Drawings

The Contractor shall use only the dimensions stated in figures on the Drawings in setting out the Works and dimensions shall not be scaled from the Drawings, unless required by the Employer's Agent. The Employer's Agent will, on the request of the Contractor, and in accordance with the provisions of the Conditions of Contract, provide such dimensions as may have been omitted from the Drawings.

The Contractor shall ensure that accurate As-Built records are kept of all infrastructure installed or relocated during the contract. The position of pipe bends, junction boxes, duct ends, and all other underground infrastructure shall be given by either co-ordinates, or stake value and offset. Where necessary, levels shall also be provided.

A marked-up set of Drawings shall be kept and updated by the Contractor on a day-to-day basis. This information shall be supplied to the Employer's Agent Representative on a regular basis.

All information in possession of the Contractor where required by the Employer's Agent and/or the Employer's Agent Representative to complete the As Built/Record Drawings, must be submitted to the Employer's Agent Representative before the Certificate of Completion may be issued.

The Drawings prepared by the Employer for the permanent Works are listed and bound under **Appendix J.**

The Employer reserves the right to issue amended and/or additional Drawings during the Contract.

C3.2.5 Design Procedures

The Contractor is responsible for the design of all the temporary works required for the construction and

execution of the Permanent Works. This includes, inter alia, temporary roads, access control, accommodation of traffic, shoring of trenches and excavations, dewatering, all health and safety measures, environmental management as well as temporary support systems, until the completion of the Contract.

C3.3. PROCUREMENT

C3.3.1 Preferential Procurement Procedures

All works to be completed in this contract shall be executed in accordance to the O. R. Tambo District Municipality's preferential procurement policies and procedures.

C3.3.2 Subcontracting

C3.3.3 Scope of Mandatory Subcontract Works

Where possible, work that can be subcontracted to EMEs and QSEs is identified and detailed in Part C1, Section C1.4 and in Part C1, Section C1.3, the requirements for the procurement and employment of local labour are specified. It is noted that the work identified in this document is not exhaustive and it shall be required from the Contractor to ensure that a minimum of 30% of the Works is done by local EMEs and QSEs.

No work may be sub-contracted to another party unless approval is given by the ORTDM in writing. The Contractor is to submit to the ORTDM in writing a request for appointment of a particular sub-contractor. Accompanying this request is to be the full detail of the sub-contractor, including:

- Previous experience.
- Work which will be sub-contracted to him/her.
- Approximate value of the work to be sub-contracted.

C3.3.4 Preferred Subcontractors / Suppliers

The Contractor will be required to liaise with the Employer, Employer's Agent and local community structures to finalise the list of local EMEs and QSEs to be employed as part of the project.

C3.3.4.1 Subcontracting Procedures

A formal tender process will be followed to appoint the Subcontractor which will be facilitated by the Employer, Employer's Agent and Main Contractor.

All subcontractors appointed under **C3.3.2.1** above shall be:

- Registered with the CIDB
- Allocated work within the category and value limits designated by their CIDB grading
- Be in good standing with the Department of Labour
- Registered on the Central Supplier Database.

Proof of the above is to be provided to the Employer's Agent before appointment of the subcontractor.

C3.3.5 Attendance on subcontractors

The Contractor shall guide, assist, advise and mentor the local EME and QSE subcontractor/s and guidance on how to establish and determine rates.

The Contractor shall be responsible for ensuring that the prospective local EME and QSE subcontractor/s fully comprehends the:

- Implications of the liabilities and responsibilities inherent in the contract into which the tenderer entered.
- Implications of the tendered rates.
- Scope and extent of the Works.
- Proper procedures for the submission of a tender.
- Procedures and basis on which tenders will be evaluated and awarded.

The Contractor shall closely manage, mentor, supervise, guide and assist the EEs in all aspects of management, planning, execution and the completion of work.

The above shall include inter alia, but is not limited to, the following:

(i) Planning and programming of the Works.
(ii) The sourcing, ordering, purchasing, hiring all the necessary Construction Equipment, Materials, tools and incidentals necessary and required for the successful execution and completion of the Permanent as well as the Temporary Works.
(iii) Labour relations and employment.
(iv) Monthly measurements, costing and invoicing.
(v) General safety, occupational health and safety matters.
(vi) Functions of civil engineering infrastructure, structures, services and systems.
(vii) Interpreting and understanding the contract.
(viii) Construction and maintenance methods and procedures.
(ix) Communication.
(x) Cash-flow control, submitting invoices and payment certificates.
(xi) Planning, programming, scheduling, critical path control and acceleration.
(xii) Maintenance planning.
(xiii) Material procurement and control.
(xiv) Risk limitation and management.
(xv) Quality assurance and procedures.
(xvi) Compliances with all applicable laws, regulations, statutory provisions and agreements.
(xvii) General Conditions of Contract and Contract Data.
(xviii) Contractual claims, if situations arise that entitle a contractor to claims in terms of the Conditions of Contract.
(xix) Profit and loss.
(xx) Replacement and running costs of Construction Equipment.

The extent and level of management, mentorship, supervision, guidance and assistance to be provided by the Contractor shall be in commensuration with the expertise of the relevant EME and QSE and should be so directed as to enable the EME and QSE to achieve the successful execution and completion of the respective works.

C3.4. CONSTRUCTION

C3.4.1 WORKS SPECIFICATIONS

C3.4.1.1 Applicable SANS 1200 Standardised Specifications

The SANS 1200 Standardised Specifications for civil engineering construction that are applicable are listed in C3.7.1.

C3.4.1.2 Particular Specifications

The Particular Specifications for work not covered by the SANS 1200 Standardised Specifications are listed in C3.7.1 and included in C3.7.3.

C3.4.1.4 Variations and Additions to the SANS 1200 Standardised Specifications

Variations and additions to the SANS 1200 Standardised Specifications listed in C3.7.1 are given in section C3.7.2.

C3.4.2 SITE ESTABLISHMENT

C3.4.2.1 Services and facilities provided by the Employer

(a) Water Sources

The Contractor shall make his own arrangements regarding the supply of water.

The Contractor shall, in accordance with the provisions of subclause C3.4.2.2(b), and at his own expense, make all arrangements necessary for the supply and distribution of water as may be required for the purposes of executing the Contract, including water for both construction purposes and domestic use as well as for making all arrangements in connection therewith.

The Contractor shall further, at his own expense, be responsible for providing all necessaries for procuring, storing, transporting and applying water required for the execution of the Contract, including but not limited to all piping, valves, tanks, pumps, meters and other plant and equipment, as well as for all work and superintendence associated therewith. Payment for the aforementioned shall be deemed to be covered by the rates and prices tendered and paid for the various items of work included under the Contract.

The Contractor shall make himself thoroughly acquainted with the regulations relating to the use of water and shall take adequate measures to prevent the wastage of water.

The sources of all water utilised for the purposes of the Contract shall be subject to the prior approval of the Employer’s Agent, which approval shall not be unreasonably withheld. The Contractor shall comply with all prevailing legislation in respect of drawing water from natural and other sources and shall, when required by the Employer’s Agent, produce proof of such compliance.

The distribution of water shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations. All water provided by the Contractor for construction purposes shall be clean, free from undesirable concentrations of deleterious salts and other materials and shall comply with any further relevant specifications of the Contract.

The Contractor shall, whenever reasonably required by the Employer's Agent, produce test results demonstrating such compliance. Water provided by the Contractor for human consumption shall be healthy and potable to the satisfaction of the health authorities in the area of the Site.

The Employer accepts no responsibility for the shortage of water due to any cause whatsoever or for the additional costs incurred by the Contractor as a result of such shortage.

(b) Power / Electricity Supply

The Contractor shall make his own arrangements with the Electricity Department for a supply of electricity if required and shall pay establishment and consumption costs at the tariffs ruling at the time.

The Contractor shall, in accordance with the provisions of subclause C3.4.2.2(c), and at his own cost, make all arrangements necessary for the supply and distribution of electrical power required for construction purposes as well as for use in and about his site establishment.

The Contractor shall comply with all prevailing legislation in respect of the generation and distribution of electricity and shall, when required by the Employer's Agent, produce proof of such compliance.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of electricity, the costs of which will be deemed to be in the Contractor's tendered rates and prices.

(c) Excrement Disposal / Sanitary Facilities

The Contractor shall, in complying with his obligations in terms of subclause C3.4.2.2(d), at his own cost, be responsible for safely and hygienically dealing with and disposing of all human excrement and similar matter generated on the Site during the course of the Contract, all to the satisfaction of the responsible health authorities in the area of the Site.

All such excrement shall be removed from the Site and shall not be disposed of by the Contractor on the Site. The Contractor shall further comply with any other requirements in this regard as may be stated in the Contract.

The Contractor shall further, as a minimum, supply and maintain chemical toilets for use by his workmen. The number of toilets shall be based on one toilet per fifteen personnel on site.

Under no circumstances will the Contractor's staff be allowed to use any other toilet facilities in and around the Site.

(d) Disposal Site

All material cleared on the site, rubble, spoil and refuse shall be disposed of at the one of the municipal solid waste sites. Hazardous material shall only be disposed of at the waste site with Waste license issued by the Department of Environmental Affairs.

These are dedicated disposal sites and therefore no separate overhaul shall be paid. The Contractor shall pay all charges levied at the waste site and must make allowance in his rates to cover these charges as no separate payment will be made in this regard.

(e) Area for Contractor's site establishment

The Employer has no suitable areas available where the Contractor may erect offices, workshops, stores and other facilities that he requires for the purposes of the Contract. The Contractor shall, at his own cost, be responsible for locating and making all arrangements necessary for securing an area suitable to meet his needs in respect of the erection of the Contractor's offices, stores and other facilities, including the facilities

to be provided for the Employer's Agent in accordance with the Contract.

Any potential area proposed by the Contractor shall be within reasonable proximity to the Site of the Works and its location shall be subject to the approval of the Employer's Agent, which approval shall not be unreasonably withheld.

The Contractor shall be responsible for arranging, at his own cost, for the provision of all services he may require in the area, as well as elsewhere on the Site.

(f) Accommodation of employees

The Contractor shall make his own arrangements for the accommodation of his employees. Where field accommodation is required, the Contractor shall comply fully with the wishes of the various landowners, as in their agreement with the Employer, to the satisfaction of both landowner and Employer.

C3.4.2.2 Facilities provided by the Contractor

The Contractor shall provide for the use of the Employer's Agent, maintain and service, as applicable, the following facilities as specified in SANS 1200 AB and PSAB.

(a) Facilities for the Employer's Agent

The Contractor shall provide on the Site, for the duration of the Contract and for the exclusive use of the Employer's Agent and/or his Employer's Agent's Representative (as applicable), the various facilities described hereunder. All such facilities shall be provided promptly on the commencement of the Contract and failure on the part of the Contractor to provide any facility required in terms of this specification shall constitute grounds for the Employer's Agent to withhold payment of the Contractor's tendered Preliminary and General items until the facility has been provided or restored as the case may be.

(i) Contract Nameboard

The Contractor shall provide, erect and maintain 2 No. of Contract Nameboards at such positions and locations as directed by the Employer's Agent. The Contractor shall, before ordering or manufacturing any such Contract nameboards, obtain the Employer's Agent written approval in respect of all names and wording to appear on the Contract nameboards. The Contractor shall keep the Contract nameboard in good state of repair for the duration of the Contract and shall remove them on completion of the Contract.

(ii) Health and Safety Sign Board

The Contractor shall erect and maintain 1No. of Health and Safety Sign Board at such positions and locations as directed by the Health and Safety Agent and the requirements specified on the Health and Safety Plan.

(iii) Office building

The Contractor shall provide on the Site an office for the exclusive use of the Employer's Agent and his Representative. Such office shall comply with and be furnished in accordance with the requirements of subclause 3.2 of SANS 1200 AB and PSAB. The Contractor shall maintain the office in accordance with the requirements of subclause 5.2 of SANS 1200 AB.

Such office accommodation shall be provided within the Contractor's site establishment facilities.

(iv) Site Meeting venue

The Contractor shall provide within his own site establishment facilities, a suitably furnished office or other venue capable of comfortably accommodating a minimum of **fifteen** (15) persons at site meetings. The Employer's Agent shall be allowed free use of such a venue for conducting any other meetings concerning the Contract at all reasonable times.

(v) Survey equipment and assistant(s)

The Contractor shall, for the duration of the Contract, in accordance with the requirements of PSAB provide survey equipment for the exclusive use of the Employer's Agent and his staff.

The Contractor shall, in accordance with the requirements of subclause 5.5 of SANS 1200 AB, make available to the Employer's Agent, two (2) survey assistants.

(vi) Site Instruction Book

The Contractor shall always keep a triplicate book for site instructions on the Site.

(b) Water

The Contractor shall, at his own expense, be responsible for obtaining and distributing all water as may be required for the purposes of executing the Contract, including water for both construction purposes and domestic use, as well as for making all arrangements in connection therewith.

The Contractor shall further, at his own expense, be responsible for providing all necessaries for procuring, storing, transporting and applying water required for the execution of the Contract, including but not limited to all piping, valves, tanks, pumps, meters and other plant and equipment, as well as for all work and superintendence associated therewith.

The sources of all water utilised for the purposes of the Contract shall be subject to the prior approval of the Employer's Agent, which approval shall not be unreasonably withheld.

The Contractor shall comply with all prevailing legislation in respect of drawing water from natural and other sources and shall, when required by the Employer's Agent, produce proof of such compliance. The distribution of water shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations.

All water provided by the Contractor for construction purposes shall be clean, free from undesirable concentrations of deleterious salts and other materials and shall comply with any further relevant specifications of the Contract. The Contractor shall, whenever reasonably required by the Employer's Agent, produce test results demonstrating such compliance. Water provided by the Contractor for human consumption shall be healthy and potable to the satisfaction of the health authorities in the area of the Site.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of water, the costs of which will be deemed to be included in the Contractor's tendered rates.

(c) Electricity

The Contractor shall, at his own expense, be responsible for obtaining and distributing all electricity as he may require for the purposes of executing the Contract, including electricity for both construction purposes and domestic use, as well as for making all arrangements in connection therewith.

The distribution of electricity shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations.

No separate payment will be made to the Contractor for the procurement, distribution and consumption of electricity, the costs of which will be deemed to be in the Contractor's tendered rates and prices.

(d) Excrement disposal

The Contractor shall, at his own expense, be responsible for safely and hygienically dealing with and disposing of all human excrement and similar matter generated on the Site during the course of the Contract, to the satisfaction of the responsible health authorities in the area of the Site and the Employer's Agent. All such excrement shall be removed from the Site and shall not be disposed of by the Contractor on the Site.

The Contractor shall further comply with any other requirements in this regard as may be stated in the Contract.

No latrines are available and therefore the Contractor shall supply portable chemical toilets for use by his workmen. The number of toilets shall be based on one toilet per fifteen personnel on site. Under no circumstances will the Contractor's staff be allowed to use private or public toilet facilities.

The Contractor shall provide water and soap for his staff to be able to wash with at each site of the Works. The wastewater shall be disposed of off-site.

No separate payment will be made to the Contractor in respect of discharging his obligations in terms of this subclause and the costs thereof shall be deemed to be included within the Contractor's tendered Preliminary and General Items.

C3.4.2.3 Site Usage and Security on site

Access to site shall be limited to the Contractor and his personnel. The Contractor shall be responsible to control unauthorised entry to the site and shall inform the Employer's Agent of any breach of such rules. The site shall be managed and used for its intended purpose. The Contractor is required to keep a visitors log and ensure full compliance with site safety standards.

The Contractor shall make provision for security on site against theft and robbery, as his sole responsibility. The cost for providing adequate security, as and when required, must be borne by the Contractor.

C3.4.2.4 Permits and Wayleaves

The Contractor shall be responsible for obtaining all of the necessary wayleaves, permissions or permits applicable to working near any existing services or other infrastructure on Site, and shall ensure that any wayleaves, permissions or permits obtained by the Employer's Agent prior to the award of the contract are transferred into the Contractor's name.

The Contractor shall abide by any conditions imposed by such wayleaves, permissions or permits.
The Contractor shall ensure that all wayleaves, permissions and permits are kept on site and are available for inspection by the relevant service authorities on demand.

The Contractor shall also ensure that any wayleaves in respect of electricity services are renewed timeously every three months.

C3.4.2.5 Features requiring special attention

(a) Site maintenance

During progress of the work and upon completion thereof, the Site of the Works shall be kept and left in a clean and orderly condition. The Contractor shall store materials and equipment for which he is responsible in an orderly manner and shall keep the Site free from debris and obstructions.

The general neatness and tidiness along the pipe route is to be maintained and therefore the Contractor shall on a day-to-day basis, keep the area of the Works in a condition acceptable to the Employer's Agent, the Employer's Health and Safety Agent and the Environmental Control Officer.

(b) Testing and Quality Control

(i) Contractor to engage services of an independent laboratory

Notwithstanding the requirements of the Specifications pertaining to testing and quality control, the Contractor shall engage the services of an approved independent laboratory to undertake all testing of materials, the results of which are specified in, or may reasonably be inferred from, the Contract. These results will be taken into consideration by the Employer's Agent in deciding whether the quality of materials utilised, and workmanship achieved by the Contractor comply with the requirements of the Specifications. The foregoing shall apply irrespective of whether the specifications indicate that the said testing is to be carried out by the Employer's Agent or by the Contractor.

The Contractor shall be responsible for arranging with the independent testing laboratory for the timeous carrying out of all such testing specified in the Contract, at not less than the frequencies and in the manner specified. The Contractor shall promptly provide the Employer's Agent with copies of the results of all such testing carried out by the independent laboratory.

For the purposes of this clause, an "independent laboratory" shall mean an "approved laboratory" (as defined in subclause PSA 7.2) which is not under the management or control of the Contractor and in which the Contractor has no financial interest, nor which has any control or financial interest in the Contractor.

(ii) Additional testing required by the Employer's Agent

In addition to the provisions of subclause C3.4.2.5(b)(i): Contractor to engage services of an independent laboratory, the Employer's Agent shall be entitled at times during the Contract to require that the Contractor arrange with the independent laboratory to carry out any such tests, additional to those described in subclause C3.4.2.5(b)(i), at such times and at such locations in the Works as the Employer's Agent shall prescribe. The Contractor shall promptly and without delay arrange with the independent laboratory for carrying out all such additional testing as required by the Employer's Agent, and copies of the test results shall be promptly submitted to the Employer's Agent.

(iii) Cost of Testing

a) Testing in term of subclause C3.4.2.5(b)(i)

The costs of all testing carried out by the independent laboratory in accordance with the requirements of subclause C3.4.2.5(b)(i), above shall be borne by the Contractor and shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities and which require testing in terms of the Specifications. No separate payments will be made by the Employer to the Contractor in respect of any testing carried out in terms of subclause C3.4.2.5(b)(i).

Where, as a result of the consistency of the materials varying or as a result of failure to meet the required specifications for the work, it becomes necessary to carry out additional tests (e.g. re-tests on rectified work and/or replacement materials), the costs of such additional testing shall be for the Contractor's account.

b) Additional tests required by the Employer's Agent

The costs of any additional tests required by the Employer's Agent in terms of subclause C3.4.2.5(b)(ii): Additional testing required by the Employer's Agent, shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Bill of Quantities; provided always that the costs of any such additional tests ordered by the Employer's Agent, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved are/is not in accordance with the specifications, shall not be reimbursable to the Contractor.

(c) Contractor supplied equipment

The Contractor shall when required to supply any testing, measuring and/or survey equipment for the Employer's Agent's use provide calibration certificates or verification certificates (as appropriate) for all equipment. This shall apply for both shared equipment as well as for equipment specified to be provided for the Employer's Agent's use on site.
Calibration or verification, by certified authorities shall be subject to the Employer's Agent's approval prior to the delivery of any equipment to the Employer's Agent; and thereafter at intervals as prescribed for the relevant equipment but not less than every twelve (12) months.

The calibration or verification certificate for each item of equipment shall be submitted to the Employer's Agent for approval prior to its use or within seven (7) days of subsequent re-calibration/verification.

Unless otherwise provided for in the bill of quantities the cost of providing the above specified equipment shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities.

Failure to submit certificates shall result in payment for the equipment being withheld.

(d) Opening up and closing don of designated borrow pits

Measurement and payment for opening up and closing down designated borrow pits, including removing and stockpiling overburden and restoring the Site, shall be made under item 8.3.4 of SANS 1200 D. This item applies to all borrow material required under this Contract.

The requirements of subclause 5.2.2.2 of SANS 1200 D regarding the opening up, maintenance and closing down of borrow pits shall be adhered to.

(e) Access to properties

The Contractor shall organise the work to cause the least possible inconvenience to the public and to the property owners adjacent to or affected by the work, and except as hereunder provided, shall at all times provide and allow pedestrian and vehicular access to properties within or adjoining or affected by the area in which he is working. In this respect the Contractor's attention is drawn to Clause 8.1.2 of the Conditions of Contract.

If, as a result of restricted road reserve widths and the nature of the work, the construction of bypasses is not feasible, construction shall be carried out under traffic conditions to provide access to erven and properties.

Notwithstanding the afore-going, the Contractor may, with the prior approval of the Employer’s Agent (which approval shall not be unreasonably withheld), make arrangements with and obtain the acceptance of the occupiers of erven and properties to close off part of a street, road, footpath or entrance temporarily, provided that the Contractor duly notifies the occupiers of the intended closure and its probable duration, and reopens the route as punctually as possible. Where possible, such streets, roads, footpaths and entrances shall be made safe and reopened to traffic overnight. Such closure shall not absolve the Contractor from his obligations under the Contract to provide access at all times. Barricades, traffic signs, drums and other safety measures appropriate to the circumstances shall be provided by the Contractor to suit the specific conditions.

(f) Monthly statements and payment certificates

The statement (measured quantities) to be submitted by the Contractor in terms of Clause 6.10 of the Conditions of Contract shall be prepared by the Contractor at his own cost, strictly in accordance with the standard payment certificate prescribed by the Employer’s Agent, in digital electronic computer format. The Contractor shall, together with a copy of the digital electronic computer file of the statement, submit two (2) A4 size paper copies of the statement.

For the purposes of the Employer’s Agent payment certificate, the Contractor shall subsequently be responsible, at his own cost, for making such adjustments to his statement as may be required by the

Employer’s Agent for the purposes of accurately reflecting the actual quantities and amounts which the Employer’s Agent deems to be due and payable to the Contractor in the payment certificate.

The Contractor shall, at his own cost, make the said adjustments to the statement and return it to the Employer's Agent within three (3) normal workings days from the date on which the Employer's Agent communicated to the Contractor the adjustments required. The Contractor shall submit to the Employer's Agent five (5) sets of A4 size paper copies of such adjusted statement, together with a copy of the electronic digital computer file thereof.

Any delay by the Contractor in making the said adjustments and submitting to the Employer's Agent the requisite copies of the adjusted statement for the purposes of the Employer's Agent payment certificate will be added to the times allowed to the Employer's Agent in terms of Clause 6.10.4 of the Conditions of Contract to submit the signed payment certificate to the Employer and the Contractor. Any such delay will also be added to the period in which the Employer is required to make payment to the Contractor.

The Contractor is further required to complete the monthly reporting template forms, refer to PSA 8.1.2.2 and Appendix B. These forms shall be submitted together with the Contractor's monthly payment certificates. Payment of the Contractor is conditional on this information being accurate and timeously provided. The Employer's Agent payment certificate template will be used as the only format for submission to the Employer.

The monthly statements accompanying the payment certificates shall include:

i. Contractor's Invoice;
ii. Interim Payment Certificate;
iii. Proof of Delivery and Invoices of all materials Claimed as Materials on Site;
iv. Construction Progress Report, including all items as per C1.4 Item 4.2 Monthly Returns
v. Programme update
vi. Cashflow vs Expenditure to date report, , including all items as per C1.4 Item 4.2 Monthly Returns
vii. Proof of Job Creation / Signed Labour Returns
viii. Detailed report on monthly and cumulative Contract Participation Goals achieved, as per Item C1.4 Item 4.2 Monthly Returns.

(g) Construction in restricted areas

Working space is sometimes restricted. The construction method used in these restricted areas largely depends on the Contractor's Plant. Notwithstanding, measurement and payment will be strictly according to the specified cross-sections and dimensions irrespective of the method used, and the rates and prices tendered will be deemed to include full compensation for any difficulties encountered by the Contractor while working in restricted areas. No extra payment nor any claim for payment due to these difficulties will be considered.

(h) Notices, signs, barricades and advertisements

All notices, signs and barricades, as well as advertisements, may be used only if approved by the Employer's Agent. The Contractor shall be responsible for their supply, erection, maintenance and ultimate removal and shall make provision for this in his tendered rates.

The Employer's Agent shall have the right to instruct the Contractor to move any sign, notice or advertisement to another position, or to remove it from the Site of the Works if in his opinion it is unsatisfactory, inconvenient or dangerous.

(i) Workmanship and quality control

The onus to produce work that conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings rests with the Contractor, and the Contractor shall, at his own expense, institute a quality control system and provide suitably qualified and experienced Employer's Agents, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing and mix designs carried out by the Contractor, will be deemed to be included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various Standardised Specifications regarding the minimum frequency of testing required. The Contractor shall, at his own discretion, increase this frequency where necessary to ensure adequate control.

On completion and submission of every part of the work to the Employer's Agent for examination and measurement, the Contractor shall furnish the Employer's Agent with the results of the relevant tests, mix designs, measurements and levels to demonstrate the achievement of compliance with the Specifications.

C3.4.2.6 Extension of time due to abnormal rainfall

a) Extension of time in respect of delays resulting from wet climatic conditions on the Site will only be considered in respect of abnormally wet climatic conditions and shall be determined for each calendar month or part thereof, in accordance with the formula given below:

$$V = (Nw - Nn) + \frac{(Rw - Rn)}{X}$$

Where:

V = Extension of time in calendar days in respect of the calendar month under consideration:

If V is negative and its absolute value exceeds Nn, then V shall be taken as equal to minus Nn.
When the value of V for any month exceeds the number of days in the particular month, V will be the number of days in the month.

Nw = Actual number of days during the calendar month on which a rainfall of 10 mm or more has been recorded.

Nn = Average number of days in the relevant calendar month, as derived from existing rainfall records, on which a rainfall of 20mm or more has been recorded for the calendar month.

Rw = Actual average rainfall in mm recorded for the calendar month under consideration.

Rn = Average rainfall in mm for the calendar month as derived from existing rainfall records as
stated in the Site Information.

The factor (Rw - Rn)/X shall be deemed to be a fair allowance for variations from the average number of days during which the rainfall did not exceed Y mm but wet conditions prevented or disrupted work.

b) The rainfall records for Mthatha for the period 2000 to 2020 from South African Weather Service (see Appendix G) are reproduced in the accompanying table, and the monthly averages (Rn and Nn) for

c) this period shall, for the purposes of this Contract be taken as normal and as the values to be substituted for Rn and Nn. The values of X and Y shall be 20 and 10 respectively.

d) The potential extension of time V has been calculated for each month and year of the period concerned to indicate the possible effect of the rainfall formula. The values of V were obtained by applying the rainfall formula and using the actual rainfall figures and the calculated values of Rn and Nn indicated in the table.

e) The Contractor shall, at his own cost, provide and erect on the Site at a location approved by the Employer's Agent, an approved rain gauge, which shall be fenced off in a manner which will prevent any undue interference by workmen and others. The Contractor shall, at his own cost, arrange for the reading of the rain gauge on a daily basis for the duration of the Contract. The gauge readings, as well as the date and time at which the reading was taken shall be recorded in a separate record book

f) provided by the Contractor for this purpose. All entries in the rainfall record books shall be signed by the person taking the reading and the gauge shall be properly emptied immediately after each reading has been taken. If required by the Employer's Agent, the Employer's Agent shall be entitled to witness the reading of the gauge.

g) The Contractor's claims in terms of Clause 5.12 of the Conditions of Contract for extension of time in respect of delays resulting from wet climatic conditions on the Site during each month, shall be submitted in writing to the Employer's Agent monthly; provided always that

(i) the period allowed to the Contractor in terms of Clause 10 of the Conditions of Contract in which to submit his claim for each month shall be reduced to seven (7) days, calculated from the last day of the month to which the claim applies; and

(iii) the 28-day period allowed to the Employer's Agent in terms of Clause 10.1.2 of the Conditions of Contract in which to give his ruling on the claim, shall be reduced to fourteen (14) days.

The Contractor's monthly claim shall be accompanied by a copy of the signed daily rainfall readings for the applicable month.

h) The extent of any extension of time which may be granted to the Contractor in respect of wet climatic conditions (whether normal or abnormal) shall be determined as the algebraic sum of the "V" values for each month between the Commencement Date and the Due Completion Date of the Contract, calculated using the formula above; provided always that:

    (i) rainfall occurring within the period of the Contractor's Christmas shut-down period (referred to in the Conditions of Contract) shall not be taken into account in the calculation of the monthly "V" values;

    (ii) rainfall occurring during any period during which the Contractor was delayed due to reasons other than wet climatic conditions on the Site, and for which delay an extension of time is granted by the Employer's Agent, shall not be taken into account in the calculation of the monthly "V" values;

(iii) if the algebraic sum of the "V" values for each month is negative, the time for completion will not be reduced on account of subnormal rainfall, and

(iv) where rainfall is recorded only for part of a month, the "V" value shall be calculated for that part of the month using pro rata values for Nn and Rn.

i) The Employer's Agent shall, simultaneous with granting any extension of time in terms of this clause, revise the Due Completion Date of the Contract to reflect an extension of time having been granted in

j) respect of wet climatic conditions, to the extent of the algebraic sum of all the "V" values for all the preceding months of the Contract, less the aggregate of the "Nn" values for the remaining (unexpired) months of the Contract (viz less aggregate of the potential maximum negative "V" values for the remaining Contract Period). Thus, provided that where such period is negative, the Due Completion Date shall not be revised.

k) Any extension of time in respect of wet climatic conditions granted in terms of this clause shall not be deemed to take into account delays experienced by the Contractor in repairing or reinstating damage to or physical loss of the Works arising from the occurrence of abnormal climatic conditions. Extension of time in respect of any such repairs or reinstatement regarding damage shall be the subject of a separate application for extension of time in accordance with the provisions of Clause 5.12 and Clause 10 of the Conditions of Contract.

MONTH	**N_n**	**R_n**
January	1.8	103.8
February	1.7	84.8
March	1.8	92.5
April	1.0	57.3
May	0.5	21.6
June	0.3	9.7
July	0.3	18.2
August	0.2	25.8
September	0.4	39.0
October	1.2	53.0
November	1.9	86.8
December	1.8	84.1
TOTAL	**13**	**676.6**

C3.4.3 PLANT AND MATERIALS

C3.4.3.1 Plant and materials supplied by the Employer

The Employer will not provide any plant. The Contractor shall provide all plant of whatever nature necessary to enable him to undertake the works as specified.

C3.4.3.2 Materials, Samples and Shop Drawings

Materials or work, which does not conform to the approved samples submitted in terms of Clause 7.4.1 (GCC 2015) of the Conditions of Contract, will be rejected. The Employer's Agent reserves the right to submit samples to tests to ensure that the material represented by the sample meets the specification requirements.

The costs of any such test conducted by or on behalf of the Employer's Agent, the results of which indicate that the samples provided by the Contractor do not conform to the requirements of the Contract, shall, in accordance with the provisions of Clause 7 of the Conditions of Contract, be for the Contractor's account.

C3.4.4 CONSTRUCTION EQUIPMENT

C3.4.4.1 Requirements for equipment

All construction plant and equipment used on this contract shall be in good working order, well maintained, of adequate size and fit for purpose. No plant or equipment that leaks oil, fuel or hydraulic fluids may be used on site.

Equipment must be such that work can be executed in an efficient manner.

Any plant or equipment that, in the opinion of the Employer's Agent, is not of adequate size or fit for use shall be removed from the site and replaced with acceptable plant and equipment, all at the Contractor's cost.

All equipment must comply with the requirements as stipulated in the Environmental regulations and specifications and contained in the OHS Act.

C3.4.4.2 Equipment provided by the Employer

The Employer shall not provide any equipment.

C3.4.5 EXISTING SERVICES

C3.4.5.1 Known services

The Contractor shall familiarise himself with all existing services and liaise with all relevant authorities for the location and detection of existing services.
No guarantee can be given that all affected services are indicated on the drawings, or that, if they are shown, they are shown exactly in the correct location. Once located, the exact location, level and nature of the service shall be recorded and given to the Employer's Agent's Representative in writing.

The Contractor shall, subject to the provisions of PSA 5.4, expose all services by hand in advance of his trenching operation in order to reduce the risk of damage to existing services.
The Contractor shall take special care not to damage any existing services and shall comply with all the requirements of the relevant authorities during construction. The Contractor will be held solely responsible for the protection of all known services and for any claims for damages arising from damage to any such service. (See also PSA 5.4).

C3.4.5.2 Treatment of existing services

The Contractor to ensure that existing services supply are not interrupted. All existing services have to remain operational, either through protection or re-routing. Temporary re-routing of existing services is allowed, with the approval of the owner of the service.

C3.4.5.3 Use of detection equipment for the location of underground services

The Contractor to make use of the necessary detection equipment to determine the location of an existing service, before excavation commences to expose the service.

C3.4.5.4 Damage to services

The Contractor shall take special care not to damage any existing services and shall comply with all the requirements of the relevant authorities during construction. The Contractor will be held solely responsible for the protection of all known services and for any claims for damages arising from damage to any such service. (See also PSA 5.4).

Damage that occurs to unknown services during construction will be paid by the Employer.

C3.4.5.5 Reinstatement of services and structures damaged during construction

The Contractor will be responsible for the repair and reinstatement of damaged services in compliance with the service owner's specifications.

C3.5. MANAGEMENT OF THE WORKS

C3.5.1 SPECIFICATIONS

The following Specifications are applicable:

(i) The SANS 1200 Standardised Specifications listed in C3.7.1.
(ii) The Particular Specifications given in C3.7.2; and
(iii) The Variations and Additions to the SANS 1200 Standardised Specifications given in C3.7. 3.

C3.5.2 PLANNING AND PROGRAMME

C3.5.2.1 General

The Contractor’s Programme to be submitted in terms of Clause 5.6.1 of the Conditions of Contract shall take all matters that may impact the Contractor's sequence of executing the various components of the Works and the requisite rate of progress of the Works, as may be specified in or reasonably inferred from the Contract.

C3.5.2.2 Format

The Construction Programme to be submitted by the Contractor in accordance with the provisions of Clause 5.6.1 of the Conditions of Contract shall;

(a) Be in the form of a bar chart; and
(b) Clearly indicate the start and end dates and duration of all construction activities and identify the critical path; and
(c) Take full cognizance of all the Contractor’s risks and obligations in terms of the Contract.

The said Programme and all revisions thereto shall also be provided to the Employer’s Agents in electronic digital format using the MS PROJECT software on a Monthly basis as per Clause 5.6.4.

C3.5.2.3 Failure to maintain construction programme

If the Construction Programme has to be revised in terms of the Conditions of Contract, because the Contractor is falling behind in its programme, the Contractor shall submit a revised programme of how it intends to regain lost time to ensure completion of the Works before the Due Completion Date.

C3.5.2.4 Additional Programming Information

The following (but not limited to) programming information shall be incorporated into the Contractor’s initial programme and all subsequently adjusted programmes. The Contractor’s programme shall also take full account of the matters described in the sub-clauses hereunder. No additional payments will be made to the Contractor in respect of any additional costs as it may incur in consequence of arranging or adjusting its programme to accommodate the said matters and the Contractor’s various tendered rates and prices shall be deemed to fully inclusive of such costs.

(a) Time related items, in respect of the following:

(i) Time to submit documentation before commencing to carry out the Works – refer to Clause 5.3.1 C1.2 of Contract Data
(ii) Construction Regulations, 2014 requirements:
- Regulation 3, Construction work permit process period
- Regulation 4, notification of construction works period

(iii) Due Completion Date

(b) All special non-working days defined in the Contract Data.
(c) Contractor's annual shutdown period between December and January
(d) Allowance for a 30 – day float period in the programme for unforeseen circumstances
(e) Meeting the requirements of the Environmental Management Plan
(f) The time needed for preparation and approval of the various mix designs specified in the relevant construction sections of the Scope of Works.

C3.5.3 QUALITY PLANS AND CONTROL

Refer the various and applicable SANS/SABS specifications, the general health and safety specifications and subsequent health and safety plan, the Conditions of Contract as well as the various clauses within the Scope of Work.

The Contractor to submit the Quality Management Plan for the approval by the Employer's Agent before commencing any work.

C3.5.4 ENVIRONMENTAL MANAGEMENT

The Contractor will be responsible for managing his activities so that damage to the environment is minimised, as per the approved Environmental Management Plan contained in Specification PEM. A payment item is included in the Bill of Quantities to cover the Contractor's cost for compliance and provision of the Method Statement.

C3.5.5 FORMAT OF COMMUNICATIONS

All contractual communication shall be in writing.

The Contractor shall, for the full duration of the Contract Period, supply and maintain the following documentation:

(a) Site Communication and Request Book.
(b) Safety File containing all relevant safety data.
(c) Daily register of all labour, plant and equipment.
(d) Quality Control file containing all quality control/assurance forms and records.
(e) One full set of Contract Drawings and documents.
(f) Latest revision of the Construction Programme.

The above-mentioned shall be kept on Site and shall be accessible to the Employer's Agent at all times.

C3.6. HEALTH AND SAFETY

The Contractor will be responsible for managing his health and safety activities as per the approved Health and Safety Plan, as indicated in Specification PHS. A payment item is included in the Bill of Quantities to cover the Contractor's cost for compliance.

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014

C3.6.1 HEALTH AND SAFETY REQUIREMENTS AND PROCEDURES

(a) Construction Regulations, 2014

The Contractor shall be required to comply with the Occupational Health and Safety Act, 1993: Construction Regulations, 2014 (the regulations) as promulgated in Government Gazette No 37305 and Regulation Gazette No 10113 of 7 February 2014 including COVID-19 requirements. Non-compliance with these regulations, in any way whatsoever, will be adequate reason for suspending the Works.

The proposed type of work, materials to be used and potential hazards likely to be encountered on this Contract are detailed in the Project Specifications, Bill of Quantities and Drawings, as well as in the Employers' health and safety specifications (regulation 5(1)(b)) of the Construction Regulations 2014, which are bound in the Contract document.

The Contractor shall in terms of regulation 7(1)(a) provide a comprehensive Health and Safety Plan detailing his proposed compliance with the regulations, for approval by the Employer.

The Contractor shall at all times be responsible for full compliance with the approved plan as well as the Construction Regulations and no extension of time will be considered for delays due to non-compliance with the abovementioned plan or regulations.

A payment item is included in the Bill of Quantities to cover the Contractor's cost for compliance with the OHS Act and the abovementioned regulations.

C3.6.2 PROTECTION OF THE PUBLIC

The Contractor to ensure the sufficient screening and barricading of the site of works is done to prevent unauthorised public access. If screening/barricading will impact on the movement of the public, the Contractor is to ensure that safe detour routes are allowed and clearly indicated.

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.3 BARRICADES AND LIGHTING

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.4 TRAFFIC CONTROL ON ROADS

The Contractor shall carry out, erect and maintain such temporary works and provide all temporary road signs, pipes, deviations, warning boards, barricades, signs, lighting and demarcations and the like, as are necessary to maintain and safeguard the normal flow of public and private vehicular and pedestrian traffic.

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014

C3.6.5 MEASURES AGAINST DISEASE AND EPIDEMICS

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014. The Contractor also needs to refer to the Health and Safety Specification and the COVID-19 specification included as Specification PHS to this document for measures to be deployed on site.

C3.6.6 AIDS AWARENESS

The Contractor is required to refer to SANS 1921 – 6 as further amended below and HIV/AIDS Awareness Education Specification (Appendix D). Payment items have been included in the Schedule of Quantities to ensure compliance.

SANS 1921-6	
Variations	
Clause	Specification Data
1 e)	Appointment of an HIV / AIDS Awareness Champion.
4.1 f)	Appointing an HIV/ AIDS Awareness Champion within 14 days of site handover from amongst the workers (which could include the Community Liaison Officer). The champion should be able to speak, read and write English, speak and understand the local languages spoken by the Workers and shall be on site at all stages of the construction period. The Contractor shall ensure that the Awareness Champion has been trained by the Service Provider on basic HIV/AIDS information, the support services available and has the necessary skills to handle questions regarding the HIV/AIDS programme in a sensitive and confidential manner. The Awareness Champion shall be responsible for: • Liaising with the Service Provider to assist in organising awareness workshops; • Filling condom dispensers and monitoring condom distribution; • Handing out information booklets; • Placing and maintaining posters
4.1 g)	Provide information about the names of the closest service providers to be displayed on a poster of size not smaller than A2.
4.2.3 c)	Understand and communicate the purpose of voluntary HIV/AIDS testing and counselling.
4.2.3 d)	Recognise the importance of caring for people living with HIV/AIDS and be familiar with the various treatments available, including treatment of opportunistic infections.
4.2.3 e)	Understand and communicate the rights and responsibilities of those living with HIV/AIDS in the workplace and the importance of non-discrimination.
4.3.2	The HIV/AIDS Awareness Champion and the Employer's representative shall certify the report and schedule described in 4.3.1 whenever a claim for payment is issued to the Employer.
5	Sanctions In the event that the Contractor fails to satisfy the requirements of this specification, the Employer may apply sanctions which include the rejection of claims for payment as being incomplete or the withholding of completion certificates (interim or final).

C3.7. PROJECT SPECIFICATIONS

PART A: CIVIL WORKS

C3.7.1 LIST OF APPLICABLE SPECIFICATIONS

C3.7.1.1 Applicable SANS 1200 Standardised Specifications

For the purpose of this Contract the latest issues of the following Standardised Specifications for Civil Engineering Construction, applicable at the date of the tender advertisement shall apply:

SANS 1200 A:	GENERAL
SANS 1200 AB:	EMPLOYER’S AGENT'S OFFICE
SANS 1200 C:	SITE CLEARANCE
SANS 1200 D:	EARTHWORKS
SANS 1200 DB:	EARTHWORKS (PIPE TRENCHES)
SANS 1200 DK:	GABIONS AND PITCHING
SANS 1200 G:	CONCRETE (STRUCTURAL)
SANS 1200 HA:	STRUCTURAL STEELWORK (SUNDRY ITEMS)
SANS 1200 L:	MEDIUM-PRESSURE PIPELINES
SANS 1200 LB:	BEDDING (PIPES)
SANS 1200 LE:	STORMWATER DRAINAGE

Any reference to a SABS standard, in any context or forum, will be deemed to be a reference to the corresponding SANS standard, and vice versa. Any ambiguity in relation to the standard specifications to be referred to the Employer’s Agent for clarity, in terms of the GCC 2015 3rd edition.

The term “project specifications” appearing in any of the SANS 1200 standardised specifications must be replaced with the term “Scope of Work”

C3.7.1.2 Particular Specifications

The following Particular Specifications for work not covered by the SANS 1200 Standardised Specifications are also included hereunder:

PC:	NO-FINES CONCRETE
PEM:	ENVIRONMENTAL MANAGEMENT
PHS:	HEALTH AND SAFETY

C3.7.2 VARIATIONS AND ADDITIONS TO SANS 1200 STANDARDISED SPECIFICATIONS

SANS 1200 A:	GENERAL
SANS 1200 AB:	EMPLOYER’S AGENT'S OFFICE
SANS 1200 C:	SITE CLEARANCE
SANS 1200 D:	EARTHWORKS
SANS 1200 DB:	EARTHWORKS (PIPE TRENCES)
SANS 1200 DK:	GABIONS AND PITCHING
SANS 1200 G:	CONCRETE (STRUCTURAL)
SANS 1200 HA:	STRUCTURAL STEELWORK (SUNDRY ITEMS)
SANS 1200 L:	MEDIUM-PRESSURE PIPELINES

SANS 1200 LB:	BEDDING (PIPES)
SANS 1200 LE:	STORMWATER DRAINAGE

The following variations and additions to the SANS 1200 Standardised Specifications referred to shall apply to this Contract. The prefix "PS" indicates an amendment to SANS 1200. The prefix "PSA" indicates an amendment to SANS 1200 A, "PSDB" to SANS 1200 DB and so on. The letters and numbers following these prefixes respectively indicate the relevant Standardised Specification and clause numbers in SANS 1200 to which the variation or addition thereto applies.

An asterisk (*) placed next to a PS Subclause number denotes the inclusion of an additional Subclause for which no equivalent appears in SANS 1200.

The term "project specifications" appearing in any of the SANS 1200 Standardised specifications must be replaced with the term "Scope of Work".

Further to the above it should be noted that where in a specific Standardised Specification reference is made to a Subclause in another Standardised Specification, any amendment or addition to the Subclause referred to, as provided for in the Specification, shall apply. The aforementioned shall also apply with respect to Clauses referred to in a Particular Specification.

PSA GENERAL

PSA 1 SCOPE

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

"1.1 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."

PSA 2 INTERPRETATIONS

PSA 2.3 DEFINITIONS

In the opening phrase, insert the words: "the definitions given in the Conditions of Contract and" between the words "specification" and "the following".

a) General

Add the following definitions:

'Employers' Agent' (Clause 1.1.1.16 of Conditions of Contract) shall have the same meaning and be synonymous with Engineer throughout the Contract documentation.

'General Items' (Clause 1.1.1.21 of Conditions of Contract) shall have the same meaning and be synonymous with Preliminary and General items.

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

Specified As specified in the Standardised Specifications, the Drawings or the Scope of Work. "Specifications" shall have the corresponding meaning."

c) Measurement and payment

Replace the definitions for "Fixed charge", "Time-related charge" and "Value-related charge" 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, the amount of which varies in accordance with the Time for Completion of the Works, adjusted in accordance with the provisions of the Contract.

Value-related charge. A charge, the amount of which varies pro rata with the final value of the measured work executed and valued in accordance with the provisions of the Contract."

PSA 2.4 ABBREVIATIONS

a) Abbreviations relating to standard documents

Add the following abbreviation:

"CKS: SANS Co-ordinating Specification."

PSA 3 MATERIALS

PSA 3.1 QUALITY

Where applicable, materials shall bear an official standardisation mark.

Add the following:

"Where proprietary materials are specified, it is to indicate the quality or type of materials or articles required, and where the terms “or similar approved” or “or approved equivalent” are used in connection with proprietary materials or articles, it is to be understood that the approval shall be at the sole discretion of the Employer’s Agent."

“PSA 3.3* ORDERING OF MATERIALS

The quantities set out in the Bill 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 purposes.”

PSA 4 PLANT

PSA 4.1 SILENCING OF PLANT

Replace the contents of Clause 4.1 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 (Act No. 85 of 1993) as amended.

The Contractor shall at all times and at its 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.”

PSA 4.2 CONTRACTOR'S OFFICES, STORES AND SERVICES

Add the following new paragraph before the existing paragraph in Clause 4.2:

"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 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.

No personnel may reside on the Site. Only night-watchmen may be on the Site after hours."

Delete “and first-aid services” in the second paragraph of Clause 4.2 and add the following:

"The Contractor shall provide on the Site and in close proximity to the actual locations where the work is being executed, one toilet per 15 workmen, which toilets shall be effectively screened from public view and their use 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 Contractor shall, where applicable, make all necessary arrangements and pay for the removal of night soil."

“PSA 4.3* RESTRICTION ON THE USE OF PLANT

Except for the type of plant, and to the extent permitted or approved by the Employer’s Agent, the Contractor shall use only hand tools and equipment in the construction of the Works, or portion(s) of the Works, that are required to be constructed using labour intensive methods.”

PSA 5 CONSTRUCTION

PSA 5.1 SURVEY

PSA 5.1.1 <u>Setting out of the Works</u>

The installed benchmarks shown on the Drawings shall be used by the Contractor for setting out the works.
Add the following paragraph:

"The Contractor shall be required to check and verify, prior to commencement of any construction work, all benchmarks and boundary reference pegs, as shown and detailed on the Drawings. Reference and benchmark pegs disturbed and/or removed during the construction period shall be replaced by a Professional Land Surveyor and the Contractor shall bear the cost of such replacement. Payment to check and verify the reference and benchmark pegs will be made in terms of PSA 8.8.5.

Where labour intensive work is specified, the Contractor shall be responsible for the setting out of the task work."

PSA 5.1.2 <u>Preservation and replacement of survey beacons and pegs subject to the Land Survey Act</u>

Delete from the second sentence "Before the commencement . . . . “to” . . . . apparently in their correct positions" and replace with the following:

"Immediately on taking over the site, the Contractor, in consultation and liaison with the Employer’s Agent, shall search for all pegs and the Contractor shall compile a list of pegs that are apparently in their correct position."

Replace the third sentence of Clause 5.1.2 with the following:

“At completion of the Contract, the Contractor shall expose and mark 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 the replacement of pegs that have become disturbed or damaged. The Contractor shall, as a precedent to the issue of the Certificate of 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 replacement and certification as aforesaid shall be entirely for the Contractor's account, provided 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 and to the satisfaction of the Employer's Agent, were disturbed, damaged or destroyed by others beyond its control, and

(c) were in close proximity to the work and which would unavoidably be removed, subject to the Employer's Agent approval being given to remove such pegs."

Add the following:

PSA 5.1.3 As-built Survey

The Contractor shall supply the Engineer with as-built survey data for the entire works, including cover and invert levels, coordinates of manholes, reservoirs, chambers and structures, points of intersection, etc. The Certificate of Completion will not be issued until the as-built survey data has been approved by the Engineer.

PSA 5.2 WATCHING, BARRICADING AND LIGHTING AND TRAFFIC CROSSINGS

Add the following:

"The Contractor shall comply in all aspects with the requirements of the Occupational Health and Safety Act (Act 85 of 1993), refer also PSA 5.7, PSA 5.9 and PSA 5.10."

PSA 5.3 PROTECTION OF STRUCTURES

Replace:" 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 insert the following after "(Act No. 27 of 1956)": "as amended".

PSA 5.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES

Replace the heading and the contents of Clause 5.4 with the following:

"PSA 5.4 LOCATION AND PROTECTION OF EXISTING SERVICES

PSA 5.4.1 <u>Location of existing services</u>

Before commencing with any work in an area, the Contractor shall ascertain the presence and actual position of all services 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 its 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 it intends to work.

Neither the Employer nor the Employer's Agent offer 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. No excavation may commence until the position of the service at the crossing point has been marked out and verified by an official of the responsible authority.

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 requirements of Clauses 4.4 and 5.1.2.2 of SANS 1200 D (as amended) shall also 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 Contractor to be present or potentially present on the Site.

All services, the positions of which have been determined as aforesaid at 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 should any such service be encountered or discovered on the Site.

Whilst it 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 cognisance 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;

as well as for consequential damage, whether caused directly by the Contractor's operations or by the lack of proper protection; provided always that the Contractor will not be held liable in respect of damages occurring to services not being Known Services.

No separate payment will be made to the Contractor in respect of any costs incurred in preparing and submitting to the Employer's Agent, the Drawings as aforesaid and these costs shall be deemed included in the Contractor's other tendered rates and prices included in the Contract.

Payment to the Contractor's 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 therefore in the respective sections of the Specifications pertaining to the type of work involved.

PSA 5.4.2 Protection during construction

The Contractor shall take all reasonable precautions and arrange its 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 there from 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.

PSA 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, unless approved by the Employer's Agent.
The Employer will accept no liability for damages due to a delay in having alterations or repairs effected by the respective service owners. The Contractor shall provide all reasonable opportunity, access and assistance to persons carrying out alterations or repairs of existing services."

PSA 5.8 GROUND AND ACCESS TO THE WORKS

Add the following:

The Contractor shall further, before commencement of any of the Works, compile a photographic / video recording of all the existing roads, structures, fences, gates, pipeline routes and trees which may be affected during the Works.

Payment will be made in terms of PSA 8.3.2.2 and PSA 8.4.2.3."

"PSA 5.9* MAINTAINING SERVICES IN USE

The Contractor shall take note that he shall not cut off any service in use without the prior approval of the Employer's Agent.

Failure on the part of the Contractor to comply with any of the above provisions will constitute sufficient reason for the Employer's Agent to stop the works until the situation has been remedied, or should he deem it necessary, arrange for the situation to be remedied at the Contractor's cost.

No direct payment will be made for the cost of maintaining services in use. 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."

"PSA 5.10* DEALING WITH AND ACCOMMODATING TRAFFIC

The Contractor shall take note that the existing roads and tracks within and to the Sites shall remain operational throughout the contract period. To this end the Contractor shall provide and maintain all temporary fences, security, barriers, kerb ramps, signs, markings, flagmen, drums, lighting, personnel and all other incidentals necessary to ensure safe and easy passage of all traffic.

Temporary traffic signs etc. as well as all necessary markings shall be erected and maintained by the Contractor and the number and layout of the traffic signs shall comply with the Site Manual entitled “Safety at Roadworks in Urban Areas”, as published by the Department of Transport.

Traffic signs shall have a yellow background with either a red / black border.

No direct payment will be made for the cost of dealing with and accommodating traffic. 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. Further, the provision of PSA 5.2 shall apply.”

"PSA 5.11* SITE MEETINGS

The Contractor's authorised Construction Manager and Contracts Manager will be required to attend regular site meetings, which shall normally be held once a month on dates and at times determined by the Employer's Agent, but in any case, whenever reasonably required by the Employer's Agent. Unless otherwise indicated in the Contract or instructed by the Employer's Agent, such meetings shall be held at the Contractor's offices on the Site. At such monthly meetings, matters such as general progress on the Works, quality of work, problems, claims, payments, and safety etc, shall be discussed, but not matters concerning the day-to-day running of the Contract.

“PSA 5.12***** PROVIDING ACCESS TO ERVEN AND PROPERTIES

Access to erven and properties along the route of trenches and roads shall be provided by the Contractor at all times. To this end suitable crossings shall be constructed where required.

Temporary crossings shall be in the form of portable bridges, temporary backfill or other approved means and shall be capable of permitting the safe passage of all vehicles and pedestrians. The Contractor shall also be responsible for maintaining crossings and for removing same when they are no longer required.
If as a result of restricted road reserve widths and the nature of the Works the construction of bypasses is not feasible, construction shall be carried out under traffic in order to provide access to the properties.

The Contractor may, with the approval of the Employer's Agent, arrange with the occupiers of the affected properties to temporarily close off a portion of a road, footpath entrance, property access road or other access, provided that the Contractor shall give due notice of the intended closure and its probable duration to the occupiers and shall as punctually as possible re-open the route at the prescribed time. Where possible, roads shall be made safe and re-opened to traffic overnight. Any such closure shall be an arrangement between the Contractor and the occupiers and shall not absolve the Contractor from his obligations under the Contract to provide access at all times. Barricades, traffic signs and drums shall be provided by the Contractor to suit the specific conditions.

No direct payment will be made for the cost of providing access. 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."

"PSA 5.14* PROTECTION OF LIVESTOCK

From the time of the occupancy of the Site until the date of the Completion Certificate the Contractor shall take all measures necessary for the protection and control of livestock on the sections of the properties affected by his operations. He shall provide gates in existing fences cut by him for the purpose of access and control, and where necessary, to store materials and plant and the Contractor shall ensure that all gates are kept closed during such time as they are not actually in use by his traffic.

Where the Contractor cannot make alternative arrangements, the Contractor shall erect temporary fencing where necessary to protect livestock exposed to straying through his operations. The fencing shall be maintained in good order during construction operations and on completion of the work it shall be removed from the Site and all surfaces restored to the satisfaction of the property owner.

Payment for the protection of livestock, including the erection of temporary fences and gates where required, shall be deemed to be covered by the rates and sums tendered and paid for the various items of work included under the Contract.

Claims by property owners for loss of or injury to livestock due to negligence on the part of the Contractor, shall be settled by the Contractor."

"PSA 5.15* COMMUNITY LIAISON OFFICER (CLO) MEASUREMENT AND PAYMENT

Employment process for CLO and payment as detailed in Clause/Section C1.3 and C1.4."

"PSA 5.16* GRADUATE ENGINEER MEASUREMENT AND PAYMENT

Employment of Graduate Engineer (COW) and payment shall be as detailed in Clause/Section C1.3 and C1.4."

PSA 6 TOLERANCES

"PSA 6.4* USE OF TOLERANCES

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."

PSA 7 TESTING

PSA 7.1 PRINCIPLES
PSA 7.1.2 <u>Standard of Finished Work Not to Specification</u>

Insert the words "or checks by an approved laboratory ..." after the words "Where the Employer's Agent checks ..."in the first line of Clause 7.1.2.

PSA 7.2 APPROVED LABORATORIES

Replace the contents of Clause 7.2 with the following:

"Unless otherwise specified in the relevant specification or elsewhere in the Scope of Work, 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 testing laboratory designated by the Employer's Agent."

PSA 8 MEASUREMENT AND PAYMENT

PSA 8.1 MEASUREMENT

PSA 8.1.1 <u>Method of measurement, all sections of the Schedule</u>

Delete the words "and South West Africa".

PSA 8.1.2 Preliminary and General item or section

PSA 8.1.2.1 Contents

Replace the contents of item (c) with the following:

"The 'duration of construction' applicable to a time-related item shall be the tendered contract period for the total works, plus as applicable, the Civil Engineering Industry Holiday (Dec / Jan) and all gazetted public holidays for the Civil Engineering Industry."

REPLACE THE LAST SENTENCE OF SUBCLAUSE 8.1.2.1(B) WITH THE FOLLOWING:

"Separate items will be scheduled to cover the fixed, value-related and time-related components of the Contractor's General items (clause 1.1.1.21 of the Conditions of Contract) in respect of:

(a) Construction work period:

The number of days for reaching the Due Completion Date (Clause 1.1.1.14 of the Conditions of Contract), being the number of days for achieving Practical Completion of the Works, as specified in the Contract Data and as adjusted by such extensions of time or acceleration as may be allowed in terms of Contract.

(b) Construction Work Permit process period (if applicable):

The actual number of days that the Employer or his agent (in terms of the Construction Regulations, 2014) takes to process and issue the instruction to commence with the Works (Clause 5.3.3.2 of the Conditions of Contract, as amended) from the date of submission of the documentation referred to in Clause 5.3.1 of the Conditions of Contract.

PSA 8.1.2.2 Tendered sums

Replace the contents of this Sub-Clause with the following:

"Except only where specific provision is made in the Specifications and/or the Bill of Quantities for separate compensation for any of these items, the Contractor's tendered sums under items PSA 8.3.1 and PSA 8.4.1 shall collectively cover all charges for:

- risks, costs and obligations in terms of the Conditions of Contract and of this standardised specification; and
- head-office and site overheads and supervision; and
- profit and financing costs; and
- expenses of a general nature not specifically related to any item or items of the permanent or temporary work; and
- providing such facilities on site as may be required by the Contractor for the proper performance of the Contract and for its personnel, including, but without limitation, providing offices, storage facilities, workshops, ablutions, services such as water, electricity, sewage and rubbish disposal, access roads and all other facilities required, as well as for the maintenance and removal on completion of the works of these facilities and cleaning-up of the site of the Contractor's establishment and reinstatement to not less than its original condition, and

- providing the facilities for the Employer's Agent and his staff as specified in the Contract and their removal from the site on completion of the Contract.
- completion of monthly reporting template forms (Refer to Appendix B for Pro Formas)"

PSA 8.2 PAYMENT

PSA 8.2.1 Fixed-charge and Value-related items

Replace the contents of Clause 8.2.1 with the following:

"Payment of fixed charges in respect of Clause 8.3.1 (Contractual requirements) will be made as follows:

(a) EIGHTY PERCENT (80%) of the sum tendered will be paid when the facilities have been provided and approved; and

(b) The remaining TWENTY PERCENT (20%) will be paid when the Works have been completed, the facilities have been removed and the site of the Contractor's establishment has been cleared and cleaned to the satisfaction of the Employer's Agent.

No adjustment will be made to the sum tendered in respect of item 8.3.1 should the value of the Works finally executed, or the Time for Completion vary in any way from that specified in the Tender.

The fixed charged items will include all associated cost to deal with the compulsory sub-contracts, other than cost already included under clause 8.3.1.

Payment for the sum tendered under clause 8.3.2 (Establishment of facilities on site) will be made in three separate instalments as follows:

(a) The first instalment, which is 40% of the sum, will be paid when the Contractor has fulfilled all its obligations to date under this Specification, the General Conditions of Contract and the Special Conditions of Contract, and when the value of work certified for payment, excluding materials on Site and payments for preliminary and general items, is equal to not less than 5% of the total value of the work listed in the Schedule of Quantities.

(b) The second instalment, which is 40% of the sum, will be made when the amount certified for payment, including retention monies but excluding this second instalment, exceeds 50% of the Tender Sum.

(c) The final payment, which is 20% of the sum, will be made when the Works have been certified as completed and the Contractor has fulfilled all its obligations to date under this Specification, the General Conditions of Contract and the Special Conditions of Contract.

Should the value of the measured work finally completed be more or less than the Tender Sum, the sum tendered under clause 8.3.2 will be adjusted up or down in accordance with the provisions of Clause 7.8 of the Conditions of Contract, and this adjustment will be applied to the third instalment.

The fixed charged items will include all associated cost to deal with the compulsory sub-contracts, other than cost already included under clause 8.3.2."

PSA 8.2.2 Time-related items

Replace the contents of Clause 8.2.2 with the following:

"Subject to the provisions of subclauses 8.2.3 and 8.2.4, payment under item PSA 8.4.1 (time-related preliminary and general charges) will be made as follows:

(a) Construction work period:

Payment shall be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the number of days stated in Contract Data (Clause 1.1.1.14) in months.

Payment for this item shall be inclusive of the time specified in Clause 1.1.1.14 plus any Extension of Time for Practical Completion but shall exclude all days included in PSA 8.2.2(b) and PSA 8.2.2(c).

(b) Construction work permit process period (if applicable):

Payment shall be for the actual number of days it takes the Employer or his agent (in terms of the Construction Regulations, 2014) to process and obtain a construction work permit (if applicable) after the submission of documentation contemplated in Clause 5.3.1 of the Conditions of Contract. The number of days stated in the Contract Data is for tendering purposes only and shall not be used as an entitlement to substantiate any claim.

The daily rate shall be fully inclusive of all costs associated with this period (refer Programme – Scope of Works) and no claim for additional cost will be considered.

The Contractor shall note that any EoT during this period will be extended by the number of days and will be compensation for at the rate priced for in the BOQ."

provided always that the total of the monthly amounts so paid for the item is not out of proportion to the value of the progress of the Works as a whole.

Should the Employer's Agent grant an extension of time for the completion of the total works, the Contractor will be entitled to an increase in the sums tendered for time-related items, which increase shall be in the same proportion to the original tendered sums, as the extension of time is to the duration of construction as defined in PSA 8.1.2.1. The Contractor shall however note that the aforementioned will not apply to extensions of time granted in terms of PSA 8.4.6.

Payment of such increased sums will be taken to be as full compensation for all additional preliminary and general costs, either time-related costs or fixed costs that result from the circumstances pertaining to the extension of time granted."

The payment to the Contractor for Time-Related Items shall be adjusted in accordance with the following formula in the event of the Contract being extended by means of a Variation Order (VO):

Sum of Tendered amounts for Time Related Items x <u>Extension of Time authorised by VO</u>

Tender Contract period

For the purposes of applying this formula "Extension of Time" will exclude the Contractor's December / January close-down period, if applicable.

The abovementioned adjustment of the payment for Time-Related Items shall be made in the completion Payment Certificate and shall be the only payment for additional Time-Related costs irrespective of the actual period required to complete the Contract including its authorised extensions.

In the case of fixed price contracts, the amount by which the Time-Related Items is adjusted shall not be subject to the Contract Price Adjustment formula.

In the case of contracts subject to Contract Price Adjustment the amount by which the time-related items are adjusted shall be subject to the Contract Price Adjustment formula."

PSA 8.3 SCHEDULED FIXED-CHARGE AND VALUE-RELATED ITEMS

REPLACE THE CONTENTS OF SUBCLAUSE 8.3.1 WITH THE FOLLOWING:
"PSA 8.3.1 Fixed preliminary and general charges. Unit: sum

The sums tendered shall include full compensation for all fixed-charge preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.1.1.

PSA 8.3.2 Value-related preliminary and general charges. Unit: sum

The sums tendered shall include full compensation for all value-related preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.1.2."

"PSA 8.3.2.1 Facilities for the Employer's Agent as specified in PSAB ....Unit: sum"

"PSA 8.3.2.2 Facilities for the Employer's Agent as specified in PSA & PSAB ....Unit: sum"

PSA 8.4 SCHEDULED TIME-RELATED ITEMS

PSA 8.4.1 <u>Contractual requirements</u> ....Unit: Sum

REPLACE THE CONTENTS OF SUBCLAUSE 8.4 WITH THE FOLLOWING:

"PSA 8.4.1 Time-related preliminary and general charges

The sum tendered shall include full compensation for all time-related preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.2."

(a) Construction work period .... Unit: sum

(b) Construction work permit process period (if applicable) ....Unit: days

"PSA 8.4.2.1 Facilities for the Employer's Agent as specified in PSAB ....Unit: sum"

"PSA 8.4.2.2 Facilities for the Employer's Agent as specified in PSA & PSAB ....Unit: sum"

"PSA 8.4.6* <u>Compensation in terms of Subclause 5.12.2.4 and Clause 9 of the Conditions of Contract for delays incurred:</u>

(a) Plant.. Unit: Sum per working day
(b) Labour.. Unit: Sum per working day
(c) Supervision .... Unit: Sum per working day
(d) Other services, facilities etc. not covered by
(a), (b) and (c) .... Unit: Sum per working day

The sum tendered for each item shall cover the full and final standing cost per day of delaying the specified resource or facility and no additional compensation shall apply, notwithstanding any provisions to the contrary in the contract documents, or in respect of any extension of time granted in relation to the circumstances described in Subclauses5.12.2.4 and 9 of the Conditions of Contract.
For the purposes of calculating the total delay, a working week shall be held to consist of five working days and a working day 9 hours.

Payment for the partial standing of any of the scheduled resources for a day or part thereof, or the standing of a complete resource for a part day, will be made pro-rata in proportion to an appropriate factor assessed by the Employer's Agent.

The amount by which compensation for delays is adjusted shall be subject to the contract price adjustment formula as defined in the Conditions of Contract.

This payment item shall only apply to delays which in the opinion of the Employer's Agent are due to the circumstances described in Subclauses 5.12.2.4 and 9 of the Conditions of Contract. No Payment will be made for any salary related or other internally caused strikes. The cost of delays incurred for all other circumstances shall be treated as provided for in the Conditions of Contract.

The provision of this Clause shall in no way prejudice the right of either the Employer or the Contractor to determine the Contract in terms of the provisions of Clause 9 of the Conditions of Contract.

The Contractor shall take note that no payment will be considered for any additional cost incurred in protecting his plant and site establishment, as well as for costs incurred in respect of damage to constructional plant and equipment."

PSA 8.5 SUMS STATED PROVISIONALLY BY THE EMPLOYER'S AGENT

Replace the contents of Clause 8.5 with the following:

"PSA 8.5.1 <u>Works Executed by the Contractor</u> .... Unit: Prov Sum

The Contractor will be reimbursed in substitution of the Provisional Sums (if any) allowed in the Bill of Quantities for work to be executed by the Contractor, in the amounts determined in accordance with the provisions of Clause 6.6 of the Conditions of Contract.

Replace Clause 8.6 with the following:

"PSA 8.6 PRIME COST ITEMS

PSA 8.6.1 <u>Prime Cost Sums</u>

(a) <u>Description of Item to which Prime Cost Sum Applies</u>.................... Unit: PC Sum
(b) <u>Charge Required by Contractor on Sub-item (a) above</u>............................ Unit: %

Sub-items (a) and (b) will be provided in the Bill of Quantities for each different item to which a Prime Cost Sum applies.

The Contractor shall be reimbursed under sub-item(s) (a) in substitution of the respective Prime Cost Sums included in the Contract, the actual price(s) paid or payable by him in respect of the goods, materials or services supplied, but excluding any charges for the Contractor's labour, profit, carriage, establishment or other charges related to such goods, services or materials.

The Contractor shall be paid under sub-item (b), the respective percentage, as stated by the Contractor in its Tender, of the amount certified by the Employer's Agent for payment under the related sub-item (a). The percentages tendered by the Contractor for each respective sub-item (b) included in the Bill of Quantities shall be deemed to in full and final compensation to the Contractor in respect of any charge by the Contractor for labour, carriage profit, establishment and for any other charges related to the goods, services or materials supplied under the related sub-item (a).

If the Contractor shall have omitted within its Tender to insert a tendered percentage under sub-item (b), or tendered a zero percentage, the Contractor's tendered rate for sub-item (b) shall be deemed to be zero and the Contractor shall not be entitled to any payment under sub-item (b)."

Note:

1. Only payments for successful test will be made under the Prime Cost Sum provided in the Bill of Quantities for "additional acceptance control testing by the Employer's Agent".

2. The Contractor is responsible for the cost of process control testing. Payment in terms of the above will only be made for acceptance control testing ordered by the Employer's Agent.

"PSA 8.7 DAYWORK

Replace the contents of subclause 8.7 with the following:

"Measurement and payment shall be in accordance with the provisions of Clause 6.5 of the Conditions of Contract."

PSA 8.8 TEMPORARY WORKS

Replace the heading and contents of subclause 8.8.1 with the following:

PSA 8.8.2 Dealing with Traffic

Delete the entire Clause. The provision of PSA 5.10 shall apply. Refer also PSA 5.2, PSA 5.3, PSA 5.7 and PSA 5.10"

PSA 8.8.4 Existing services

Replace the heading of paragraph (c) with the following:

"(c) Excavate by hand in soft material to expose existing services .... Unit: m^3

Add the following:

"The rate tendered for (c) shall further cover the cost of backfilling the excavation with excavated material compacted to 90% of modified AASHTO maximum density, loading, transporting within a free haul distance of 0,5 km and disposing of surplus material as directed, keeping the excavation safe, dealing with water, protecting the exposed services, and any other operation necessary to complete the work.

No distinction will be made between the various types of services to be exposed, or the depths to which excavations are taken.

Excavation in excess of that authorised will not be measured for payment."

PSA 8.8.5 Cost of survey in terms of Land Survey Act

Delete the entire Clause. The provision of PSA 5.10 shall apply.

"PSA 8.8.7 Dealing with water

(a) Dealing with subsurface water .... Unit: Sum
(b) Dealing with surface water .... Unit: Sum

The sum shall cover the cost for the provision, operation, maintaining and removal of all plant and materials required to deal with any water anywhere on site as required in terms of Sub clause 5.1.3 of SANS 1200 D and Sub clause 5.1.2 of SANS 1200 DB. No additional payment will be made for "Special water hazards".

The sum shall cover the cost of providing the necessary plant or materials, or both, fully erected and operative on the Site, the cost of operating and maintaining pumps, well points, sheeting, close timbering, and other equipment, as applicable, for 24 Hours a day, 7 days a week, throughout the period during which the facilities are required, and the cost of removing such goods and restoring the Site to its original condition on completion of that part of the project for which the temporary works were erected.

"PSA 8.8.8* Construct and remove temporary road to be used by the Contractor for haulage and access for the duration of the Contract ....Unit: Km

The Contractor shall determine the road width required, the necessary surface material, stormwater drainage and layerworks necessary to provide a durable and all-weather haul road.

The rate tendered shall cover the cost of all labour, plant and material necessary to construct and remove at the end of the Contract, the temporary haul road to be used by the Contractor for haulage and access to the reservoir Site.

No contractual claim or associated additional costs shall be evaluated, entertained or paid for any delays due to whatever circumstance incurred as a result of the construction, the use and the maintenance of haul or access roads."

PSA 8.9 WAYLEAVE Unit: sum

The tendered sum shall include full compensation to the Contractor for all the costs involved in obtaining all the necessary wayleaves required on the contract.

PSA 8.10 CONTRACT NAMEBOARDS Unit: No

The tendered sum shall include full compensation to the Contractor for all the costs involved in the supply, installation and maintaining of the specified number of contract nameboards as shown on the drawings, including the removal of the boards at the end of the contract period.

PSA 8.11 QUALITY MANAGEMENT PLAN Unit: sum

The costs of whatever nature for providing the Quality Management Plan as specified in Part C3 will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.12 PROVISION OF SECURITY PERSONNEL Unit: sum

The costs of whatever nature for providing security personnel the Contractor deems appropriate, taking cognisance of the location of the site, will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.13 EMPLOYMENT OF COMMUNITY LIAISON OFFICER Unit: Prov. Sum

The costs of whatever nature for Community Liaison Officers, taking cognisance of the location of the site, will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.14 EMPLOYMENT OF GRADUATE ENGINEER Unit: Prov. Sum

The costs of whatever nature for Graduate Engineer, taking cognisance of the location of the site, will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.15 SURVEY FOR AND PREPARATION OF AS-BUILT DATA Unit: sum

The sum tendered shall include all costs associated with providing the Engineer with the required as-built information of the works in terms of PSA 5.1.3.

PSAB EMPLOYER'S AGENT'S OFFICE

PSAB 3 MATERIALS

PSAB 3.1 NAMEBOARDS

Notwithstanding the provisions of this Sub-Clause, two Contract Nameboard shall be provided. The nameboard shall further comply with regards to size, painting, decorating and detail to Drawing number 1005270-0000-DRG-CC-601.

PSAB 3.2 OFFICEBUILDING(S)

Replace the words: 'as scheduled" in parenthesis in the first line of this Subclause with:

"as specified in Portion 1 of the Project Specification";

Replace 3.2d) with the following:
"d) Eight chairs"
And replace Subclause 3.2(j) with the following:

"(j) an air-conditioning unit capable of both heating in winter and cooling in summer."

Add the following items after j):

"k) 1 x Pin board to hold A0 drawing.

l) 1 x 110 ℓ refrigerator."

Add after "Employer's Agent" in the third last line:

"The minimum standard of toilet shall be the chemical type."

"PSAB 3.3* CARPORT

The Contractor shall provide on Site for the duration of the Contract three (3) number of carports for exclusive use of the Employer's Agent and his Representatives. Each car-port shall be constructed so that the vehicle parked under it is always protected against the direct rays of the sun. The carport area shall be at least 20m² and the floor shall be covered with a layer of crushed stone to alleviate dusty and muddy conditions. The carports shall be positioned so as to provide easy and convenient access to the Employer's Agent office."

"PSAB 3.3* PROTECTIVE CLOTHING

The Contractor shall provide and replace when necessary four sets of safety helmets, reflective jacket for use by Employers Agent & Employer visitors to site.

PSAB 4 PLANT

PSAB 4.1 TELEPHONE

Replace Sub-clause 4.1 of SANS 1200 AB with the following:

"One site telephone or two cellular telephone shall be made available to the Employer's Agent.

The Contractor shall, at its own cost, arrange for the provision thereof and the Contractor shall further provide associated service contracts from a reputable cellular service provider, for the exclusive use of the Employer's Agent and his staff. The Contractor shall further insure the cellular phones against loss or damage from whatever cause arising and shall ensure that all cellular phone accounts are promptly paid on the due dates for payment. The Contractor shall further, at its own cost, ensure the prompt repair of all cellular phones provided under this Clause, when reasonably required by the Employer's Agent."

"PSAB 4.2* ELECTRONIC EQUIPMENT

The Contractor will provide various items of electronic equipment for the exclusive use by the Employer's Agent and his site staff, to assist in the administration of the Contract, for the duration of construction. The electronic equipment includes a digital camera(s), software, a printer(s), scanner, GPS, and related consumables.
The Contractor shall also provide signal booster on the Site, to enable electronic devices that requires signal to function properly and maintain it for the duration of the Contractor.

The equipment shall always remain the property of the Employer's Agent, including upon completion of construction and the Contractor shall have no obligation other than the payment in terms of clause 8.6 of SANS 1200 and PSA 8.6.

"PSAB 4.3* SURVEY EQUIPMENT

The Contractor shall provide the following survey equipment for use by the Employer's Agent:

a) 1 x automatic level with tripod,
b) 1 x level staff with staff bubble,
c) 2 x ranging rods,
d) 1 x builder's spirit level of length 900 mm,
e) 1 x steel tape of length 50 m,
f) 1 x pocket tape of length 5 m,
g) 1 x steel level transfer plate,
h) 1 x measuring wheel, and
i) all steel and wood pegs, concrete, hammers, picks, etc., that the Employer's Agent may require.

The Contractor shall provide proof, at the start of the Contract, that the tacheometer and automatic level that have recently been serviced by an acceptable institution and shall, throughout the period of construction,

service and maintain all survey equipment and he shall insure same and indemnify the Employer and the Employer's Agent against all claims for loss, breakage or theft of such equipment.

All survey equipment shall be provided for the exclusive use of the Employer's Agent.
"PSAB 4.4* ACCOMMODATION FOR EMPLOYER'S AGENTSTAFF

The Employer's Agent will locate suitable accommodation for the Employer's Agent's Representative staff which shall be leased in the name of either the Contractor or Employer's Agent. The period of the lease shall extend until the end of the month in which the Completion Certificate is issued."

PSAB 5 CONSTRUCTION

PSAB 5.1 NAMEBOARDS

Replace the contents of this Clause with the following:

"The Contract Nameboards shall be erected within fourteen days of the Commencement Date and shall be placed where ordered. Any damage to this board shall be repaired within seven days of a written instruction issued by the Employer's Agent's Representative.

Further to the above the Contractor will not be allowed to erect more than two of his own nameboards in the area of the Works. The position of these shall be agreed to by the Employer's Agent. No payment will be made for the supply, erection or maintenance of the Contractor's nameboards and the Employer's Agent reserves the right to order the removal of the nameboards if not properly maintained.

All nameboards shall be removed within 7 days of the issue of the "Certificate of Completion".

PSAB 5.5 SURVEY ASSISTANTS

A survey assistant will be required from time to time to assist the Employer's Agent Representative.

PSAB 8 MEASUREMENT AND PAYMENT

Delete the contents of this Clause. The appropriate measurement and payment clauses have been included under Clause 8 of SANS 1200 A and PSA.

PSC SITE CLEARANCE

PSC 3 MATERIALS

PSC 3.1 DISPOSAL OF MATERIAL

Add the following:

"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 the various clearance items."

PSC 5 CONSTRUCTION

PSC 5.1 AREAS TO BE CLEARED AND GRUBBED

Add the following:

“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.

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

"Pipeline routes shall be cleared to a distance of between 1 - 1,5 m on both sides of the pipeline centre line. Route pegs or markers shall not be destroyed or damaged during clearing operations."

PSC 5.2 CUTTING OF TREES

PSC 5.2.3 Preservation of trees

PSC 5.2.3.2 Individual trees

REPLACE THE LAST SENTENCE WITH THE FOLLOWING:

"An amount of R100.00 will be deducted from moneys due to the contractor as a penalty for every tree that is damaged or removed unnecessarily."

PSC 5.5 RECLEARING OF VEGETATION

ADD THE FOLLOWING:

"Except if otherwise agreed, where areas have to be recleared on the written instruction of the Employer’s Agent, such reclearing shall be carried out at the Contractor’s own cost and the Contractor is advised therefore, not to clear areas at such an early stage that reclearing may become necessary.”

PSC 5.6 CONSERVATION OF TOPSOIL

ADD THE FOLLOWING:

“Conservation of topsoil, together with grass, roots and chipped mulch shall be applicable. Stockpiling of topsoil will be allowed on Site in specific locations indicated by the Employer’s Agent. Topsoil shall not be stockpiled higher than 2,0m. Care shall be exercised to prevent the compaction of topsoil in any way especially by vehicles travelling over such material.”

PSC 8.1 BASIC PRINCIPLES

ADD THE FOLLOWING:

"The thickness of the layer that will unavoidably be stripped during clearing of vegetation will be taken as 100 mm. This implies that levels used in earthworks quantity calculations will be 100 mm lower than the original levels excluding stripping of topsoil to stockpile where applicable."

ADD THE FOLLOWING:

"Levels to be used for earthworks quantity calculations will be surveyed once the clearing operation has been completed."

PSC 8.2 PAYMENT

PSC 8.2.1 Clear and grub

REPLACE THE FIRST LINE 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 metre or"

PSC 8.2.7 Dismantle, remove and reinstate pipelines, electricity transmission lines, cables, etc.

REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH:

"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."

"PSC 8.2.11 Remove topsoil to spoil site furnished by Contractor .... **Unit : m^3**

The tendered rate shall include full compensation for removing topsoil to a depth of 150 mm and for loading and transporting the material to spoil sites furnished by the Contractor.

PSC 8.2.12 Take down and re-erect existing fences .... **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, as such new material will be paid for under Particular Specification PA: FENCING.

PSC 8.2.13 Demolish existing wall and replace with Vibracrete wall Unit : m

The rate shall cover the cost of dismantling a section of wall and replacing it with a 2,1 m high Vibracrete wall. The rate shall also cover the cost of all excavation necessary and the disposal of all rubble.

PSC 8.2.14 Remove and dispose of kerbing Unit : m

The rate shall cover the cost of the removal and disposal of existing kerbs, including all necessary excavation.

PSC 8.2.15 Remove and reinstate existing:

(a) Kerbs/ Edging .... Unit : m

The tendered rates shall include full compensation for the careful removal of kerbs or edging, the temporary stockpiling and cleaning thereof and the reinstatement once the work has been completed, including all necessary excavation, backfilling and concrete bedding and backing with 15 MPa concrete. In the event of the contractor damaging any of the kerbs, he will replace it at his own cost.

PSD EARTHWORKS

PSD 2 INTERPRETATIONS

PSD 2.1 SUPPORTING SPECIFICATIONS

Replace Clause 2.1.2 with the following:

"PSD 2.1.2: Any of the other SANS 1200 Specifications may form part of the Contract Documents."

PSD 2.3 DEFINITIONS

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 excavations or borrow pits.

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."

PSD 3 MATERIALS

PSD 3.1 CLASSIFICATION FOR EXCAVATION PURPOSES

PSD 3.1.1 Method of Classifying

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."

PSD 3.1.2 Classes of excavation

Notwithstanding the provisions of this subclause no distinction will be made between soft and intermediate excavation. All excavation, other than in hard rock excavation, shall for measurement and payment purposes be classified as soft excavation.

All materials encountered in any excavation for any purpose including restricted excavation will be classified as follows:

(a) Hard rock excavation

Hard rock excavation shall be excavation in material (including undecomposed boulders exceeding 0.17 cubic metres in individual volume) that cannot be efficiently removed without wedging and splitting, or hydraulic hammers.

This classification includes materials such as:

- solid unfractured rock occurring in bulk
- solid ledges thicker than 200mm
- igneous rock intrusions
- cemented sedimentary rocks.

(b) Soft excavation

Any material which can be removed by bulldozers or backhoes, shall be classified as soft excavation.

Soft excavation shall be material not falling into the category of hard rock excavation.

(c) Boulder excavation Class A

Excavation in material containing more than 40% by volume of boulders of size in the range 0.03-20 m^3, in a matrix of soft material or smaller boulders.

Excavation in dolomite formations other than solid dolomite will be classed as boulder excavation Class A if the formation contains more than 40% by volume of lumps of hard dolomite of size in the range 0.03-20 m^3, in a matrix of soft material or smaller lumps of hard dolomite.

Excavation of solid boulders or lumps of size exceeding 20 m^3 will be classed as hard rock excavation.

Excavation of fissured or fractured rock will not be classed as boulder excavation but as hard rock or intermediate excavation according to the nature of the material.

(c) Boulder excavation Class B

Boulder excavation Class B shall be excavation of boulders only, which

1) are in material containing 40% or less by volume of boulders of size in the range 0.03-20 m^3, in a matrix of soft material or smaller boulders, and which

2) require individual drilling in order to be loaded by a track type front-ended loader or back-acting excavator, as the case may be, as specified in (a)(1)or (a)(2) above.

The excavation, of the rest of the material will be classed as soft or intermediate excavation, according to the nature of the material.

PSD 3.2.3 Material Suitable for Backfill or Fill against Structures

Replace the contents of this sub-clause 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 an excessive number of stones retained on a 50 mm sieve; and

(b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment; and

(c) The liquid limit of the material shall not exceed 40, neither shall the PI exceed 18.

(d) The minimum compaction shall be 93% of modified AASHTO maximum density."

PSD 3.3 SELECTION

PSD 3.3.1 General

Replace the second paragraph 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."

PSD 3.3.2 Backfilling and embankments

With reference to the last line of this subclause the material to be used for backfill shall be either 15MPa/19 concrete or material complying with 3.2.2 compacted in 150mm layers to 90% of modified AASHTO maximum density, as ordered on site.

ADD THE FOLLOWING NEW CLAUSE:

"PSD 3.3.3 Selection in borrow pits and excavations

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."

PSD 4 PLANT

PSD 4.4 DETECTORS

Replace the contents of Clause 4.4 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 its own cost, provide and use detecting equipment which is suitable for the detection of underground cables and pipes.”

PSD 4.2 COMPACTION

Where it is required that the work be carried out using labour intensive methods, the Contractor shall not use compaction plant larger than a walk-behind compactor.

PSD 5 CONSTRUCTION

PSD 5.1 PRECAUTIONS

PSD 5.1.1 Safety

PSD 5.1.1.1 Barricading and lighting

Replace “Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)” with “Occupational Health and Safety Act, 1993 (Act 85 of 1993) and Construction Regulations 2014”.

ADD THE FOLLOWING WORDING:

“Without limiting any obligation which the Contractor may have in terms of any Act, Ordinance or other legislation, the Contractor shall ensure that all excavations which are accessible to the public or which are adjacent to a public road or thoroughfare, or by which the safety of persons may be endangered are protected as set out in Clause 13 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 and that Watchmen are employed to ensure that barricades, barriers and lights are effective at all times.

Trench excavations shall be protected by means of at least two horizontal wires with double sided red/white; chevron tape wrapped over the wires as approved by the Employer’s Agent. The wires shall be stretched tightly between supports along both sides and ends of the excavation at levels approximately 0,45m and 1,12m above the ground. The supports shall consist of poles or iron standards securely planted in solid ground at not more than 10m centres so as to enclose the spoil and the excavations.

Bridges for vehicles and/or pedestrians shall be provided along the route of the work as and where may be considered necessary by the Employer’s Agent. They shall consist of a number of suitably sized steel plates laid across open excavated trenches. They shall be protected on each side by steel handrails, at least 1m high, securely fastened to the steel plates. At least 4 lamps or reflective markers must be provided at each crossing.

Where construction is in, or across, public roads the barricades or barriers and temporary road signs shall be erected. All such signs and positioning thereof shall comply with the requirements set out in Road Note 13 read in conjunction with the SA Road Traffic Signs Manual."

PSD 5.1.1.2 Safeguarding of excavations

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."

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."

PSD 5.1.1.3 Explosives

Replace the contents of this Clause with the following:

"No overbreak allowance shall apply to this Contract.

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. Such action by the Employer's Agent shall not entitle the Contractor to additional payment for having to resort to less economical methods of construction.

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

(c) The Contractor shall fully comply with the requirements of the Explosives Act, Act 83 of 1997 and all other legislation and regulations as may be applicable to blasting and the use of explosives.

(d) Before any 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 area.

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 the commencement of blasting operations.

(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).

(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 that the resulting exposed surfaces are as sound as the nature of the material permits. The Contractor shall make good, at its own expense, any additional excavation necessitated by the shattering of rock in excess of any overbreak allowances specified in the Project Specifications 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."

PSD 5.1.2 Existing services

PSD 5.1.2.2 Detection, location and exposure

Replace the contents of Clause 5.1.2.2 with the following:

"The exposure by the Contractor of underground services, as required in terms of Clause 5.4 of SANS 1200 A and PSA 5.4 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 the Contract or as directed.

Payment in respect of the exposing of the services by means of hand excavation as described above shall be deemed to be covered by the rates tendered under items PSA 8.8.4(c)."
Payment in respect of the reinstatement of layer works in roadways will be made in accordance with PSDB 8.3.6.1 and subclause 8.3.6.1 of SANS 1200 DB."

PSD 5.1.2.3 Protection of cables

Replace Clause 5.1.2.3 with the following:

"5.1.2.3 Protection during Construction

Further to the requirements of PSA 5.4.2 and 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 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 Sub-clause 5.4.2 of SANS 1200 A (as amended), 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."

PSD 5.1.2.4 Negligence

The Contractor shall not repair any service damaged. 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."

DELETE SUBSUBCLAUSE 5.1.2.4

PSD 5.1.5 Reinstatement and maintenance of roads

ADD THE FOLLOWING:

"Where crossings have been made, the roads shall be reinstated in accordance with the details specified in subclause 5.9 of SANS 1200 DB."

PSD 5.1.6 Road traffic control

Delete the contents of Clause 5.1.6 and replace with the following:
"The provisions of PSA 5.10 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 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.

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."

PSD 5.2 METHODS AND PROCEDURES

PSD 5.2.1 Site preparation

PSD 5.2.1.2 Conservation of topsoil

Add the following:

“Topsoil ordered to be stripped and conserved for later use shall be stockpiled in a manageable heap where designated by the Employer’s Agent. The material together with such vegetation and small roots as may occur within the specified depth shall be stripped, loaded, transported to stockpile within a freehaul distance of 0,5 km, maintained and wetted (dust control) for the full duration of the Contract or until use.”

PSD 5.2.2 Excavation

PSD 5.2.2.1 Excavation for General Earthworks and for Structures

Add the following to paragraph (b):

"When the nature of the material precludes the above procedure, additional excavations shall be carried out to provide working space for the erection of formwork. In general, payment will be made for excavating a working width of 600 mm, but the Contractor may excavate a greater working width at no additional cost to the Employer."
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 gravel material compacted to 98% of modified AASHTO density or to the density of the surrounding material, whichever is the higher density.

Where excavations for structures have been carried out in hard material, the Employer’s Agent may direct that over-excavation be backfilled with weak concrete if there is a danger of settlement or differential settlement of the foundations.

Where the sides of excavations against which 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 for the structure, 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."

PSD 5.2.2.3 Disposal

Replace the second sentence 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.

Payment to the Contractor in respect of locating and making arrangements for suitable spoil sites and spoiling material at such sites will be made in accordance with the provisions of Sub-clause PSD 8.3.15."

"PSD 5.2.2.4* <u>Selection and Stockpiling</u>

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 for which the said approval or designation relates, nor that all material in the borrow pit or excavation should be used for the particular purpose. The Contractor shall select suitable material from that borrow pit or excavation, discard unsuitable material and reserve material for other purposes as necessary.

The Contractor shall organise and carry out its operations in such a manner as will prevent the contamination of suitable embankment, fill and backfill material with unsuitable materials. Any excavated material which becomes, in the Employer's Agent opinion, unsuitable for use in embankments, fills 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 temporary stockpiled at sites indicated by the Employer's Agent for later use. The additional costs of stockpiling material shall be paid to the Contractor in accordance with the provisions of Sub-clause PSD 8.3.14."

PSD 5.2.2.5* Excavation of hard rock without blasting

Due to the fact that construction of the pipeline may be alongside existing services, pipelines and in certain areas are near structures/buildings, the Contractor shall exert maximum caution in his methods and

operations. In such cases, and where instructed by the Employer's Agent, the Contactor shall use non-explosive methods approved by the Employer's Agent. These methods include hand pneumatic hammers,

excavator mounted hydraulic hammers (breakers), expansive chemical products, or other method approved by the Employer's Agent.

The application of this Subclause will not relieve the Contractor of his responsibilities in accordance with Subclause 5.1.1.3 or otherwise in terms of the Contract.

PSD 5.2.2.6 Recording of original ground profiles

The Contractor shall inform the Employer's Agent, in writing, at least 28 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 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."

PSD 5.2.3 Placing and Compaction

PSD 5.2.3.1 Embankments

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."

PSD 5.2.3.3* 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.

Each layer shall be compacted at OMC to a density of at least 93% of modified AASHTO density in the case of cohesive soil or 100% in the case of non-cohesive soil. 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."

"PSD 5.2.3.4 Backfilling over-excavation and overbreak

The material to be used shall comply with 3.2.1, except that the maximum particle size shall not exceed $^2/_3$ of the thickness of the layer being placed and shall be compacted to at least 93% of modified AASHTO maximum density.

PSD 5.2.4.2 Finishing

a) Topsoiling

IN SUBCLAUSE 5.2.4.2, REPLACE THE WORDING "75 mm" IN THE LAST SENTENCE WITH: "100 mm"

PSD 5.2.4.3 Grass or other vegetation

ADD THE FOLLOWING:

"(a) Fertiliser/soil improvement material

The fertilisers for areas to be hydro-seeded are as follows:

i) Superphosphate – 150 kg/ha
ii) 2 : 3 : 2 (22) – 200kg/ha"

(b) Grass seeds

Only fresh certified seed shall be used, and the seed mixture shall be as follows:

Mix A – (Winter – April to June)

Westerworld ryegrass (var Midmar)	:	20 kg/ha
Cynodon Dactylon	:	20 kg/ha
Eragrosis Curvula	:	20 kg/ha
Eragrosis Tef	:	20 kg/ha

Mix B – (Summer – July to September)
As for Mix A, except that Westerworld ryegrass is substituted with Italian ryegrass (var. Turtetra)."

(c) Anti-erosion compounds
"Anti-erosion compound shall be Verdyol Complex (or similar) applied at a rate of 100kg/ha."

PSD 5.2.6.2 Grassing
(a) Hydroseeding

Mulch shall be added to the hydro-seeding mix at a rate of 2000kg/ha.

PSD 5.2.6.3 Planting and maintaining the plants

(a) Watering, weeding, mowing and replanting

The mowing of grass to control weeds shall not be measured and paid for.
PSD 5.2.5 <u>Transport for Earthworks</u>

Replace the contents of Sub-clause 5.2.5 with the following:

"The transport and haul of all excavated materials, as well as material imported from commercial sources or borrow pits selected by the Contractor, irrespective of the distance and source, shall be deemed to be freehaul, the cost of which shall be included in the Contractor's tendered rates and prices for the excavation of the materials. No separate compensation shall apply for the transportation of excavated materials."

PSD 6 TOLERANCES

PSD 6.1 POSITIONS, DIMENSIONS, LEVELS, ETC.

Add the following:

"PSD 6.1(c) <u>Bulk earthworks</u>

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

PSD 7 TESTING

PSD 7.2 TAKING AND TESTING OF SAMPLES

Replace the contents of this subclause with the following:

"The Contractor shall arrange with the approved independent laboratory engaged by the Contractor in terms of clause C3.4.9 of the Scope of Works, to carry out sufficient tests on a regular basis as agreed between it 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.

The compaction requirements for fills shall be deemed complied with when at least 75% of the dry-density tests on any lot show values equal to or above the specified density and when no single value is more than five percentage points below the specified value."

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.3 SCHEDULED ITEMS

PSD 8.3.1 Site Preparation

Replace Clauses 8.3.1.1 and 8.3.1.2 with the following:
"Where Site preparation such as clearing, grubbing, the removal of large trees or the removal and stockpiling of topsoil or surface obstructions are required, the provisions and scheduled items of SANS 1200 C shall apply."

PSD 8.3.2 Bulk Excavation

REPLACE THE CONTENTS OF ITEM WITH THE FOLLOWING:

"(a) Excavate in all materials and use for embankment or backfill as ordered, from:

(1) Necessary excavations Unit: m³

(2) Designated borrow pits Unit: m³

(3) Commercial sources Unit: m³

The unit of measurement shall be the cubic metre measured in place in accordance with subclause 8.2 of SANS 1200 D.

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 of SANS 1200 D (as amended), in addition to the cost of excavating in all materials, basic selecting, 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.

In addition to the foregoing, the tendered rate for subitem (b) shall further include for the costs of royalties (if applicable), whilst the tendered rate for subitem (c) shall also include for the costs of finding a source of suitable

material, for making arrangements with the owner of the source, for procuring the material, for the payment of all requisite royalties, charges or damages, and for transporting the material to the site regardless of the distance involved. No payment will be made for the removal of overburden or stockpiling at the commercial source and no extra over payment shall apply for excavating in intermediate, hard or boulder material."

(b) Excavate in all materials and dispose Unit: m³

The unit of measurement shall be the cubic metre of material excavated, measured in place in accordance with subclause 8.2 of SANS 1200 D.

The tendered rates shall cover the cost of complying with all the precautions required in terms of subclause 5.1 of SANS 1200 D (as amended), in addition to the cost of excavating, basic selecting, loading, transporting, off-loading at the spoil site, maintaining and finishing the spoil site, all in accordance with the specifications.

(c) Extra over subitems PSD 8.3.2(a)(1), PSD 8.3.2(a)(2) and PSD 8.3.2(b) for:

(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 subclauses 8.3.2.(a) and 8.3.2.(b) above for any portion of the excavation that is classified as hard rock, boulder excavation class A or boulder excavation class B as applicable. (See Drawing D-2.)"

PSD 8.3.3 Restricted excavation

Replace the heading of subclause 8.3.3 (a) and the contents of the first two paragraphs with the following:

"PSD 8.3.3(a) Excavate for restricted foundations, footings, trenches, stormwater drains outside road reserve, open drains and cut-off drains, in all materials, and use for fill or backfill or berm or dispose, as ordered Unit: m³

Separate items will be scheduled for each category of excavation and for each class or manner of disposal of excavated material.

All restricted excavation shall be measured by volume.

Replace "in 5.2.2.1 – 5.2.2.3 (inclusive)" at the end of subclause (a) with "in Clauses 5.2.2.1 to 5.2.2.4 (inclusive)."

Delete Clause 8.3.3(b) (1) as well as any reference to intermediate excavation in subclause (b). For the purposes of measurement and payment, excavation other than hard rock and boulder excavation will not be separately classified (refer PSD 3.1.2)."

PSD 8.3.4 Importing of Materials

Delete Clause 8.3.4(a) in totality.

PSD 8.3.6 Overhaul

Delete Sub-clause 8.3.6.

No overhaul will be paid on material for the purposes of this Contract and all costs for transporting material shall be included in the applicable tendered rates and amounts.

PSD 8.3.10 Topsoiling

CHANGE THE UNIT TO "m³" AND REPLACE THE CONTENTS OF THIS ITEM 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 irrespective of the distance, and off-loading, spreading, shaping and lightly compacting the topsoil."

PSD 8.3.11 Grassing or other Vegetation Cover
ADD THE FOLLOWING AFTER THE SECOND SENTENCE:

”The tendered rate shall be irrespective of the number of applications required to obtain the required spread rate.”

PSD 8.3.12 Road traffic signs and markings

Delete the contents of this Sub-Clause.

The provisions of PSA 5.10 shall apply.

“PSD 8.3.14* Extra over items 8.3.2.1 and PSD 8.3.3 for temporary stockpiling ....Unit: m^3

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, fills or backfill.

Measurements shall be taken in place in compacted embankment, fills or backfill as the case may be.

The tendered rate shall include for the costs, additional to those provided for in PSD 8.3.2.1 and PSD 8.3.3 of off-loading, forming and maintaining the stockpile for as long as is required, reloading and transporting regardless of the distance involved from the stockpile.

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 its own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by it in the course of executing the Works, whether such stockpiling was avoidable or otherwise.”

"PSD 8.3.15* Extra over items PSD 8.3.2 and PSD 8.3.3 for disposing of spoil material on a site provided by the Contractor...Unit: m^3

The unit of measurement shall be the cubic metre, measured in accordance with Sub-clause 8.2 of SANS 1200 D, of surplus and/or unsuitable material disposed of, on the instruction of the Employer’s Agent, at a spoil site or spoil sites provided by the Contractor.

The tendered rate shall include full compensation for the additional cost of providing a spoil site or other means of disposing of surplus spoil material, for transporting the material regardless of the distance involved, for acceptance charges for such material and for all other incidental costs to dispose of the spoil material."

"PSD 8.3.16* Extra and dispose of unsuitable material from sides or bottom of restricted foundations, footings, trenches and stormwater drains where ordered and replace with:

(a) Selected material complying with subclause 3.2.2 of SANS 1200 ME compacted to 90% of modified AASHTO maximum density...Unit: m^3

(b) 15MPa/19 concrete .... Unit: m^3

Separate items will be scheduled for each type of excavation, source of backfill material and manner of backfill.

The rates tendered shall cover the cost of excavating the unsuitable material to the extent ordered by the Employer's Agent, disposing of the material at a spoil site provided by the Contractor and subsequent backfilling of the excavation using selected material or concrete as ordered.

<u>NOTE:</u>

The work required to construct the selected layer beneath areas to be concrete lined will be measured for payment under (a) as applicable. The unit of measurement shall be the cubic metre of selected material placed and compacted. Any excavation required to accommodate the concrete lining will be deemed to be covered by subclause 8.3.4 of SANS 1200 DM."

PSDB EARTHWORKS (PIPE TRENCHES)

PSDB 3 MATERIALS

PSDB 3.1 CLASSES OF EXCAVATION

Delete the contents of Clause 3.1 and replace with the following:

“The classification shall be as described in PSD 3.1”.

PSDB 3.5 BACKFILL MATERIAL

Delete the contents of Clause 3.5(b) and replace with the following:

“In areas subject to road traffic loads which shall be held to extend 1000mm beyond the edge of the roadway, backfill shall comprise of material having a PI = 10 and a CBR at the specified density $\geq$ 45 compacted in 150mm layers to 95% of modified AASHTO maximum density.”

Add the following paragraphs to sub-clause 3.5:

"(c) Cement-stabilised backfilling

Backfilling shall, where directed by the Employer’s Agent, be stabilised with 5% cement. The aggregate shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

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

(d) Soilcrete backfilling

The aggregate for soilcrete shall be mixed with 5% cement and shall consist of approved soil or gravel containing stones not bigger than 38 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."

PSDB 3.7 SELECTION

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

REPLACE THE SECOND AND THIRD SENTENCES OF SUBCLAUSE 3.7 WITH THE FOLLOWING:

“The Contractor is required to use selective methods of excavation. The Contractor shall selectively remove and keep separate the sandy materials from unsuitable material and place it adjacent to the trench for reuse as backfill, selected fill, selected granular material, selected rockfill or for other use as ordered by the Employer’s Agent.”

ADD THE FOLLOWING AT THE END OF SUBCLAUSE 3.7:

“Material which, in terms of Subclause 6.2 of SANS 1200 D or Subclause 6.1 of SANS 1200 LB, is too wet for immediate use in the trench (but which is otherwise suitable) will not be regarded as “unsuitable” material and, if so ordered by the Employer’s Agent, the Contractor shall spread such material in a suitable area until it has dried sufficient for later use. Should the material which is replaced in the trench become too wet again, 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.

When preparing his programme and construction methods, the Contractor shall make allowance for selective excavation and the handling and drying out of materials which is too wet for immediate use.”

PSDB 4 PLANT

PSDB 4.1 Excavation equipment

Where it is required that the work is to be carried out using labour intensive methods, 4.1 shall read:

"Except that the Contractor may use the tools, equipment and plant specified for the classification of the material in the excavation of that material, the Contractor shall use only hand tools such as picks, shovels and sledgehammers".

PSDB 4.3 Compaction equipment

Where it is required that the work is to be carried out using labour intensive methods, 4.3 shall read:

"The Contractor shall use only hand tampers and hand-held pneumatic tampers to compact the material in the trench. He shall carry out his compaction in such a manner that the pipeline, duct or cable is not stressed or damaged. The material directly above the pipe, duct or cable shall not be compacted until sufficient backfill has been placed to ensure the loads transmitted to the top of the pipe, etc. are no greater than would be imposed by normal road traffic over a pipeline with cover of depth 600 mm".

PSDB 5 CONSTRUCTION

PSDB 5.1.2.2 Special water hazards
The Contractor shall take note that no special water hazards are designated. The Contractor shall therefore deal with all water as specified in 5.1.2.1, including flow into trenches due to a high or perched water table and any overland flow.

PSDB 5.1 PRECAUTIONS

PSDB 5.1.3 a) Sloping ground

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 utilised by the Contractor during the Contract from any adverse effects of soil erosion, settlement, scour, etc., resulting from the construction of the Works.

Cross embankments, generally extending across the full width of the working strip, consisting of low earth mounds shaped to rounded form and so oriented as to have a fall of 1% along their length, shall be constructed with compacted material having a minimum density of 90% modified AASHTO density and

minimum dimensions and maximum spacings dependent on the slope of the ground along the length of the pipeline, as indicated on the drawings.

Cross-embankments shall be constructed to the same minimum standards and dimensions indicated above wherever artificial slopes have been formed on the working strip or other areas used during construction and, with the approval of the Employer's Agent, are permitted to be so left.

Payment will be made for the construction of cross-embankments provided construction thereof has been either ordered or approved by the Employer's Agent prior to the commencement of such construction."

b) New Subclause under Subclause 5.1.2

ADD THE FOLLOWING NEW SUBCLAUSE TO SUBCLAUSE 5.1.2:

"5.1.2.4 Cross-walls in trenches.
In steeply sloping trenches at between 15 and 20% grade, or where erosion becomes evident on site, or where ordered by the Employer's Agent, the Contractor shall place sacks of earth as cross walls around and above the pipe up to ground level, prior to backfilling, as a soil erosion measure as indicated on the drawings.

Where required, an item will be included in the Bill of Quantities to cover the cost of the supply, installation and maintenance of sack breakers.

5.1.2.5 Concrete anchor blocks where gradient equals or exceeds 20%.
Where the grade of the pipe equals or exceeds 20% the Contractor shall provide concrete anchor blocks.

Where required, an item will be included in the Bill of Quantities to cover the cost of the supply, installation and maintenance of concrete anchor blocks, including the wrapping of the encased pipe portion with an approved tape wrapping such as Denso Ultraflex or similar approved."

c) Accommodation of traffic and access to properties

REPLACE THE SEMICOLON AND THE WORD "and" AT THE END OF SUBCLAUSE 5.1.3(a) WITH A FULL STOP AND REPLACE ITEM (b) WITH THE FOLLOWING:

"(b) Where necessary to achieve compliance by the Contractor with his obligations in terms of subclause C3.4.2.5(e) Scope of Works to provide and maintain pedestrian and vehicular access to properties affected by the works, the Contractor shall construct and maintain to the satisfaction of the Employer's 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 Employer's 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."

ADD THE FOLLOWING NEW SUBCLAUSE TO SUBCLAUSE 5.1:

"PSDB 5.1.5 Removal of existing pipelines

Where existing pipes have to be removed, they shall be carefully opened up by machine excavation 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 Employer's Agent and brought to the surface for inspection by the Employer's 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 Employer's Agent's instructions, as relevant.

"PSDB 5.2 MINIMUM BASE WIDTHS

REPLACE PARAGRAPH (a) WITH THE FOLLOWING:

"Where two pipes are placed in the same trench, they shall be 300 mm apart and the specified side allowance shall still be applicable."

ADD THE FOLLOWING AFTER PARAGRAPH (b):

"The above is not applicable to trenches for subsurface drains.

Trenches for subsurface drains shall be excavated to the dimensions and gradients shown on the Drawings or directed by the Employer's Agent.

The specified width of trenches and the width of the excavation measured for payment shall not be less than 0,5 m, but the Contractor may reduce the actual width with the Employer's Agent's permission."

PSDB 5.4 EXCAVATION

Add the following:

"Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 900 mm, except at road-crossings, where the minimum cover shall be 1000 mm .

No trench may be left open over the period 16 December to 8 January inclusive.

In the open veld the Contractor shall limit the length of trenches open, at any time, to a maximum of 300 m per pipelaying team or between fence crossings, whichever is the shorter. Similarly, the maximum length of open trenches within the villages shall be 100m.

Where trenches have to be excavated under this Contract adjacent to live services / other services laid under other contracts, it may be necessary to shore trenches to prevent damage to the live services / other services. It will be the responsibility of the Contractor to ensure that services constructed under other contracts of live services are not damaged by his operations during the Contract."

Should the Contractor detect areas where the cover is doubtful, he shall report this immediately in writing to the Employer's Agent, before any pipes are laid, so that remedial steps can be taken.

The Contractor shall exert maximum caution in excavating alongside or near existing services, pipelines, buildings or structures. The Contractor shall use non-explosive methods for the excavation of hard rock in these cases and where instructed by the Employer's Agent (see 5.2.2.5)."

PSDB 5.6 BACKFILL

PSDB 5.6.1 <u>General</u>

Replace the first sentence with the following:

"Backfilling of pipe trenches may only commence after the pipe has been laid, firmly bedded in the specified cradle, the blanket placed and compacted as specified and after the pipe has been tested in terms of Clause 7 of SANS 1200 L."

PSDB 5.6.2 <u>Material for backfilling</u>

Replace the last paragraph of this Clause "In areas……backfill" with the following:

"The material for backfilling in areas subject to road traffic loads shall comply with PSDB 3.5."

PSDB 5.6.3 <u>Disposal of soft excavation material</u>

Replace the words "unless otherwise required in the project specification." at the end of this Subclause with:

"or to spoil in accordance with the requirements of PSD 5.2.2.3 and Subclause 5.2.2.3 of SANS 1200 D, as instructed by the Employer's Agent."

PSDB 5.6.4 Disposal of intermediate and hard rock material

REPLACE THE LAST SECTION OF SUBCLAUSE 5.6.4 ".... disposed of as specified in 5.6.3 or removed to designated sites," WITH ".... disposed of outside the site boundaries."

PSDB 5.6.6 <u>Completion of backfilling</u>

Add the following:

"If in the opinion of the Employer's Agent insufficient progress is being made with the backfilling of trenches, the Employer's Agent will be entitled to order than no further excavation takes place until the backfilling operation has caught up."

ADD THE FOLLOWING:

"PSDB 5.6.9 Backfilling around structures

Backfilling around a structure shall not be commenced before it has been approved by the Employer's 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 100% of modified AASHTO density as instructed by the Employer's Agent before the succeeding layer is placed. Unsuitable or surplus excavated material shall be spoiled off site."

ADD THE FOLLOWING NEW SUBCLAUSE UNDER SUBCLAUSE 5.6:

"PSDB 5.6.10 Selection and disposal of rockfill to erosion channels.

Where directed by the Employer's Agent, the Contractor shall select rockfill from surplus excavated material and dispose of the material at erosion channels identified by the Employer's Agent.

Rockfill shall be comprised of 40% to 50% by volume of rocks/boulders of size in the range of 0.02–0.50 m^3, with the remaining volume made up of material of smaller particle sizes of which at least 80% passes a 6mm sieve. The rockfill shall be thoroughly mixed before disposal.

The material shall be disposed of at the identified erosion channel sites, to the dimensions and levels confirmed by the Employer's Agent, and compacted."

PSDB 5.7 COMPACTION

PSDB 5.7.1 <u>Areas not subject to Traffic Loads</u>

Add the following sentence:

"All non-cohesive material shall be compacted to 100% of modified AASHTO maximum density."

Replace the heading and contents of subclause 5.7.2 with the following:

PSDB 5.7.2 <u>Areas Subject to Traffic Loads</u>:

In areas subject to traffic loads, trenches shall be backfilled from the top of the bedding to the extent scheduled below in layers of thickness not exceeding 150mm after compaction, and the material shall be compacted to 95% of modified AASHTO maximum density.

TRENCH DESCRIPTION	EXTENT OF BACKFILL
Trenches beneath roadways to be constructed under the contract	Up to designated level of underside of layerworks

PSDB 5.12 UNSTABLE TRENCH BOTTOM

The Employer's 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 shall consist of 19 mm single-sized crushed stone and shall have a specified thickness of 150 mm over the specified minimum base width.

Should the material in the trench bottom or the bedding material be of such a nature that it can penetrate the stone layer, the Employer's Agent may instruct the Contractor to enclose the stone layer completely within a geotextile filter blanket which shall comply with the requirements of PSLB 3.6, and shall have overlaps of at least 200 mm.

PSDB 5.13 LENGTH OF OPEN TRENCH

No more than 300 m of trench per pipe-laying team may be open at any one time.

PSDB 5.14 DEPOSITING MATERIAL EXCAVATED FROM TRENCH

Unless otherwise ordered by the Employer's Agent, all excavated material shall be kept within 5 m of the pipeline centreline. The toe of the bank of excavated material shall be trimmed well back from the edge of the trench so as to leave a minimum 0,6 m clearance between the toe of the bank and the edge of the trench. The Contractor shall keep this strip clear of excavated material at all times.

The Contractor shall take steps to avoid burying or contaminating topsoil which shall be set aside for replacing, as far as practical, on the surface from which it was excavated.

PSDB 5.15 CLEANING UP AS WORK PROCEEDS

The Contractor shall complete all backfilling, trimming, levelling and cleaning up of the Site as work proceeds. This work shall not lag by more than 1 km behind the pipe-laying team."

PSDB 7 TESTING

The Contractor shall carry out density tests as specified in TMH1, in the positions indicated by the Employer's Agent, to determine the compaction 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, notwithstanding the terms of the second sentence of Subclause 7.1, bear the cost of all density tests carried out except as follows. Where the test results are equal to or exceed the specified density, the Employer will bear the cost of that number

of those tests ordered by the Employer's Agent in excess of one test per 20 m^3 of compacted material, based on the total volume of backfill and reinstated road layers, including the replacement of any over-excavation, in areas subject to traffic loads.

The Contractor shall also bear the cost of those density tests, carried out by the Employer's Agent, of which the test results are below the specified density.

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.1 BASIC PRINCIPLES

PSDB 8.1.1 Replace "along the route of the pipeline" in the third line of Clause 8.1.1 with "as specified in PSDB 5.6.3".

PSDB 8.1.2 ADD THE FOLLOWING:

"In the road prism or building platform the ground surface from which depth will be measured will always (irrespective of operation sequenced) be the roadbed level at centre-line."

PSDB 8.2.3 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 width determined from the applicable side allowance (see drawing 1005270-0000-DRG-CC-603) plus the nominal width of the pipe. Side allowance shall be measured from the outside of the pipe. No allowance shall be made for the extra thickness of the collars or couplings.

The side allowance for ducts shall be 150 mm and there shall be 300 mm between a Telkom duct and any other duct/service placed in the same trench.

Where two or more pipes/ducts are to be placed in one trench, the specified base width shall be calculated as follows:

The trench width for the deeper service shall be calculated according to above specifications. The effective trench width for the shallower service shall then be the difference between its specified base width and the overlap with the trench of the deeper service.

The trench width for subsurface drains shall be as shown on the drawings."

Replace the contents of subclause 8.2.4 with the following:

"No separate items will be measured for shoring. Refer to Item PSD 5.1.1.2 in this regard."

"PSDB 8.2.5* If payment in terms of PSA 8.8.4 has been made to expose an existing service and the excavation involved falls within a proposed trench, the quantity measured for trench excavation shall be reduced accordingly."

PSDB 8.3 SCHEDULED ITEMS

PSDB 8.3.2 <u>Excavation</u>

(a) <u>Excavate in all materials for trenches, backfill, compact and dispose of surplus material</u> ....Unit: m or m^3

Replace the first sentence with the following:

"Items will be provided for various trenches widths as specified and detailed on the Drawings and various depths in increments as specified in the Bill of Quantities."

Add the following to Clause (a):

"The rate tendered shall also cover the cost of complying with PSDB 3.5, as well as the cost of any disruption or delay in complying with PSDB 5.4 and PSL 5.1.4.

ADD THE FOLLOWING AT THE END OF SUBCLAUSE 8.3.2(a):

"The Contractor will be allowed to claim the following percentages for interim payment purposes, as the following various activities are completed (Note that the percentage applicable is given as a cumulative figure):

Stage Achieved	Percentage applicable for interim payment
Material excavated	65.0%
Backfill completed and compaction successfully tested	90.0%
Surplus material removed and area finished	100.0%"

Delete Clause 8.3.2 (b)(1) as well as any reference to intermediate excavation in Clause (b). For the purpose of measurement and payment, excavation other than hard rock excavation will not be separately classified (refer PSDB 3.1).

Measurement and payment shall be in accordance with the provisions of 8.3.2(b) of SANS 1200 D (as amended)."
No payments will be made under subitems (1) and (2) in respect of any materials measured and paid for under subitem (3) below."

Add the following new sub-items in 8.3.2 (b):

"(3) Extra over 8.3.2a.and PSDB 8.3.2a for disposing of spoil material on a site provided by the Contractor .... Unit: m^3

The unit of measurement shall be the cubic metre, measured in accordance with Sub-clause 8.2 of SANS 1200 D, of surplus and/or unsuitable material disposed of, on the instruction of the Employer's Agent, at a spoil site or spoil sites provided by the Contractor.

The tendered rate shall include full compensation for the additional cost of providing a spoil site or other means of disposing of surplus spoil material, for transporting the material regardless of the distance involved, for acceptance charges for such material and for all other incidental costs to dispose of the spoil material.
(4) 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, measured in place after compaction according to the authorised dimensions, which was stabilised on the Employer's Agent instructions in accordance with Sub-clause PSDB 3.5(c).

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing, backfilling and compacting the stabilised material to 90% of modified AASHTO density."

(5) 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 PSDB 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."

"(6) Hand excavation where ordered by the Employer's Agent in:

i) Soft material Unit: m^3

ii) Hard 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 Employer's Agent; provided always that the Employer's 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 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 with his obligations under the Contract to

- utilise construction appropriate to the nature of the specific parts of the works; and/or
- protect existing structures and/or services; and/or
- comply with all prevailing legislation and regulations.

Add the following subclauses after subclause 8.3.2(c):

"(d) Excavate in all materials for stormwater inlet and outlet structures
and for manholes, catchpits, valve chambers and the like,
irrespective of depth, and backfill around 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 subitems (d) and (e) for excavating in:

(1) Hard rock material Unit: m^3

Measurement and payment shall be in accordance with the provisions of 8.3.2(b) of SANS 1200 D (as amended)."
PSDB 8.3.3 Excavation ancillaries

PSDB 8.3.3.3 <u>Compaction in road reserves</u>

REPLACE THE HEADING OF SUBCLAUSE 8.3.3.3 WITH THE FOLLOWING:

" 8.3.3.3 Compaction in road crossings"

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:

"To determine the volume in the case of gravel roads, 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.

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

PSDB 8.3.3.4 <u>Overhaul</u>

Replace the contents of this subclause with the following:

“Measurement and payment shall be in accordance with subclause PSD 5.2.5.”

PSDB 8.3.6 Finishing

PSDB 8.3.6.1 Reinstate road surfaces complete with all courses

ADD THE FOLLOWING:

“Where the trench crosses asphalt road surfaces, the rate shall include for neatly saw cutting the existing asphalt surfacing on all edges.”

PSDB 8.3.7 <u>Accommodation of Traffic</u>

Delete Subclause 8.3.7. The provisions of PSA 5.10 shall apply.

ADD THE FOLLOWING ITEMS TO SUBCLAUSE 8.3:

"PSDB 8.3.8 Removal of existing pipes

(a) Excavate in all materials to 300 mm above the pipelines Unit: m^3

The unit of measurement shall be the cubic metre of material excavated for the removal of pipelines in accordance with PSDB 5.11, measured in place according to the authorised dimensions. Depth shall be measured from the ground surface on the centreline of the pipeline to 300 mm above the pipe barrel.

The tendered rate shall include for excavating by any method in all materials and placing the excavated material alongside the trench.

(b) Excavate by hand to expose pipes Unit: m

The unit of measurement shall be the linear metre of pipeline finally exposed by hand excavation methods, measured in plan view along the centreline of the pipeline, irrespective of the class of pipe. Separate items will be scheduled for each different diameter of pipe. The pipe volume as well as the volume of all associated structures such as junction boxes, manholes, valve chambers and the like shall be excluded from the volume of excavation measured.

The tendered rates shall be in full and final compensation for excavating by hand methods from a depth of 300 mm above the pipe barrel in accordance with PSDB 5.11.2 to expose the pipe to its bottom, irrespective of the type or class of pipe, as well as for excavating by hand around junction boxes, manholes, valve chambers and the like.

(c) Remove pipes from trench and stack for inspection Unit: m

The unit of measurement shall be the linear metre of each type and diameter of pipe removed from the trench in accordance with subclause 5.11, measured in plan view along the centreline of the pipeline, without deduction

for specials, junction boxes, manholes, valve chambers and the like as may be encountered. Separate items shall be scheduled for each different class and diameter of pipe.

The tendered rates shall be fully inclusive for uncoupling the individual pipes and specials, all additional excavation as may be necessary to facilitate the insertion of lifting slings or the utilisation of other lifting equipment, the provision and utilisation of all such lifting equipment as may be necessary (e.g. cranes), for lifting the pipes and specials out of the trench, cleaning and stacking them along the side of the trench for inspection, attending during the Employer's Agent's inspection and recording the Employer's Agent's decisions on each pipe/special. The tendered rate shall further include for the demolition and removal from the trench of all associated pipeline structures as may be encountered, such as junction boxes, inlet and outlet structures, valve chambers, anchor blocks and the like, and the loading and removal of the debris to spoil.

(d) Deliver pipes and specials declared reusable

(i) Pipes Unit: m

The unit of measurement shall be the linear metre of pipe declared reusable by the Employer's Agent and delivered to the address specified in subclause PSDB 5.11. Separate items will be scheduled for each different type and class of pipe.

The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the location specified in PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the pipes.

(ii) Specials Unit: number

The unit of measurement shall be the number of specials declared reusable by the Employer's Agent in accordance with subclause PSDB 5.11 above, irrespective of the type or diameter of the special, delivered to the address specified in subclause PSDB 5.11.

The tendered rate shall be fully inclusive for loading the specials at the side of the trench, transporting to and off-loading at the location specified in PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the specials.

(e) Dispose of pipes and specials unsuitable for reuse

(i) Pipes Unit: m

The unit of measurement shall be the linear metre of pipe declared by the Employer's Agent to be unsuitable for reuse and disposed of by the Contractor in accordance with the requirements of PSDB 5.11.5. Separate items will be scheduled for different types and diameters of pipe.

The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the spoil site and dealing with them as specified in PSDB 5.11.5.

(ii) Specials Unit: number

The unit of measurement shall be the number of specials declared by the Employer's Agent to be unsuitable for reuse and disposed of by the Contractor in accordance with the requirements of PSDB 5.11.5. Separate items will be scheduled for different types of special.

The tendered rate shall include for loading the specials at the side of the trench transporting them to and off-loading them at the spoil site and dealing with them as specified in PSDB 5.11.5.

(f) Backfill and compact trench Unit: m^3

The unit of measurement shall be the cubic metre of compacted fill, measured tight according to the authorised dimensions of the trench.

The tendered rate shall be fully inclusive for placing excavated material in the trench and compacting in accordance with subclauses SANS 1200 DB 5.6 and 5.7 (as amended).

(g) Make up deficiency in backfill material Unit: m^3

The unit of measurement shall be the cubic metre of backfill obtained from sources other than the trench excavated for the purposes of removing the pipeline in order to make up any deficiencies in backfill material resulting from the volume previously occupied by the pipeline.

Except that the volume shall be determined as the external volume of the pipes removed together with the external volume of all ancillary structures removed along the pipeline, measurement and payment shall be in accordance with 8.3.3.1 of SANS 1200 DB.
PSDB 8.3.9 Provision of temporary bridges for maintaining access to Properties

(a) Temporary pedestrian bridges Unit: No

(b) Temporary vehicular bridges Unit: No

The unit of measurement shall be the number of temporary pedestrian and vehicular bridges actually provided in accordance with the Specifications.

The tendered rates shall include full compensation for the supply, first installation, maintenance and final dismantling and removal of the temporary access bridges when no longer required, as specified in subclause PSDB 5.1.3.

PSDB 8.3.10 Moving of temporary bridges to and their re-erection in new positions

(a) Temporary pedestrian bridges Unit: No

(b) Temporary vehicular bridges Unit: No

The unit of measurement shall be the number of times each temporary bridge is moved to and re-erected in an entirely new position, excluding its first erection in the position where it was originally installed. No payment shall be made without the Employer's Agent's prior approval for moving and re-erecting a temporary bridge.

The tendered rates shall include full compensation for taking down, transporting, handling, re-erecting and maintaining the temporary bridges in the new positions."

PSDB 8.3.11 Slope Stabilisation

(a) Cross embankments Unit: m^3

(b) Cross Walls Unit: m^3

(c) Concrete anchor blocks 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, whichever is the lesser.

The tendered rates shall include full compensation for slope stabilisation as specified on drawings or authorised by the Employer's Agent. The rate shall include all material, labour, transporting and plant required.

PSDK GABIONS AND PITCHING

PSDK 3 MATERIALS

PSDK 3.1.2 Gabion cages

Gabions boxes shall be constructed of double twisted, hexagonal wire mesh of nominal 80 mm mesh, with 4,4 mm o/d frame wire and 3,7 mm o/d mesh wire complete with partition at 1 m centres.
All wire shall be mild steel to SANS 1580 - 1993, zinc coated by hot dip galvanizing to SANS 675 - 1993.

Gabions Mattresses shall be constructed of double twisted, hexagonal wire mesh of nominal 80 mm mesh, with 4,0 mm o/d frame wire and 3,5 mm o/d mesh wire complete with partition at 1 m centres.

All wire shall be mild steel to SANS 1580 - 2001, zinc coated by hot dip galvanizing to SANS 675 1997.

PSDK 3.1.3 Geotextile

In addition to the requirements of Subclause 3.1.3, the geotextile shall have a mass of at least 150 g/m² and a strength of at least 9,0 kN/m in all directions.

PSDK 3.2 PITCHING

PSDK 3.2.1 Stone

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

PSDK 5 CONSTRUCTION

PSDK 5.3.1 General

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.

PSDK 5.3.2 Grouted pitching

Add the following:

"The exposed stone surfaces shall be cleaned of excess mortar within 1 day of being grouted."

PSDK 5.3.3 Grouted pitching

Replace the words "(Table 4)" in the second line of the first paragraph with "(Table 2)".

PSDK 8 MEASUREMENT AND PAYMENT

PSDK 8.2 SCHEDULED ITEMS

Replace the heading and contents of Clause 8.2.1 with the following:

"PSDK 8.2.1 Surface preparation for bedding of gabions and pitching .... Unit: m^2

The rate tendered shall cover the cost of all labour, plant and equipment required to effect minor trimming and shaping as well as compact any loose material to leave a firm flat surface, ready for bedding the gabion cages, mattresses and pitching."

PSDK 8.2.5 Pitching

Notwithstanding the provisions of this Clause the excavation and backfill of footing trenches will be measured for payment under PSDK 8.2.8.

PSDK 8.2.8* Excavation and concrete backfill of footing trenches for pitching............ 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 0,5 km 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."

PSG CONCRETE (STRUCTURAL)

PSG 2 INTERPRETATIONS

a) General

ADD THE FOLLOWING:

"Construction joint.
A joint required on account of constraints or convenience in the method of construction and that is not a movement, contraction or expansion joint.

Extender:
Material which, when placed 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 (also referred to as binder):
Common cement that complies with the requirements of SANS 50197-1, and blends of certain types of common cement and cement extenders that comply with the requirements of SANS 55167-1 (2011), SANS 50450-1&2 (2011), SANS 53263-1&2 (2011) and SANS 50934-2&6 (2011) as 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"

PSG 2.4 EXPLANATION OF TERMS

PSG 2.4.1 Exposure Conditions

All concrete on the Works shall be as specified for severe exposure condition.

PSG 2.4.2 Joints

Notwithstanding Subclause 2.4.3, "designated joints" will only be joints that are shown on the drawings. Any other joints that are required by the Contractor as a result of his construction constraints or for any other reason, whether approved by the Employer's Agent or not, will not be considered to be designated joints as defined in Subclause 2.4.3, i.e. they will be considered to be "non-designated" joints.

PSG 3 MATERIALS

PSG 3.2 CEMENT

PSG 3.2.1 Applicable Specifications

Replace the contents of this subclause with the following:

"Subject to the provisions of 3.2.2, cement shall comply with the requirements of SANS 50197-1 for CEM I 42, 5 or CEM I 52.5."

PSG 3.2.2 Alternative types of cement

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 PSG5.5.1.7 and PSG 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."

PSG 3.2.3 Storage of cement

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 10 weeks without the Employer's Agent's permission."

PSG 3.4 AGGREGATES
PSG 3.4.3 Storage of aggregates

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."

"PSG 3.4.5* Aggregate for grouting

Notwithstanding the requirements of Subclause 3.4.1, the grading of the fine aggregate (sand) and coarse aggregate (stone or pea gravel) to be used for grouting shall conform to the gradings given in Tables 1 and 2 respectively, below.

TABLE 1 – SAND	
Test sieve nominal aperture size, mm	% Passing (by mass)
9,5	100
4,75	95 - 100
1,18	45 - 65
0,3	5 - 15
0,15	0 - 5

TABLE 2 - STONE OR PEA GRAVEL	
Test sieve nominal aperture size, mm	% Passing (by mass)
9,5	100
4,74	95 - 100
2,36	0 - 5

"PSG 3.4.6* Samples

At least one month before commencement of concrete work the Contractor shall supply at his own cost representative samples to the Employer's Agent of the aggregates he intends using, together with certificates from an approved laboratory indicating that the aggregates comply with the specifications. Approximately 50 kg of each sample of aggregate shall be supplied.

After approval these samples shall be taken as standard for the agreed aggregates to be used in the Works. If at any time during the course of the Contract the Employer's Agent considers that there has been any deviation from the approved standard the Contractor shall submit further tested samples of material to the Employer's Agent for approval."

"PSG 3.9* ROOFING FELT

Three-ply roofing felt shall comply with the requirements of SANS 92 for type 40 felt."

"PSG 3.10* WATERSTOPS

"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.

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 similar to the specified products and are subject to the approval of the Employer's Agent."

"PSG 3.11* CURING COMPOUND

Curing compound shall be white pigmented natural resin based liquid curing compound complying with ASTM 309-74. Curing compounds shall be suitable for use with potable water"

"PSG 3.12* STAINLESS STEEL

The following grades of stainless steel shall be used:

316L for welded applications,
316 for not-welded applications."

"PSG 3.13* BOND BREAKER

The bond breaker between the top of the blinding layer or dry packed mortar screed and the underside of the floor slab shall be 250-micrometre polythene sheet complying with SANS 952, Type D."

"PSG 3.14* MATERIALS FOR BUILDING WORK

PSG 3.14.1 Cement

The requirements stipulated for subclause 3.2.1 and PSG 3.2.1 shall apply.

PSG 3.14.2 Sand

Sand for mortar shall comply with SANS 1090.

PSG 3.14.3 Bricks

Brickwork shall be built in stretcher bond. The walls shall be built to the dimensions shown on the Drawings or ordered. All bricks shall be well soaked in water immediately before being laid and the previous course of bricks shall be well wetted before the laying of the following course.

Walls shall be carried up regularly so that no brickwork is more than 1m higher than adjoining brickwork.

All bricks shall comply with SANS 227 and shall be NFX burnt clay masonry units free of stones, cracks and other defects. The bricks shall be obtained from an approved manufacturer and samples of the bricks shall be submitted to the Employer's Agent for approval.

PSG 3.14.4 Mortar

Mortar shall comprise of the cement, lime and sand mixed in the proportions given below:

Cement: 50 kg
Lime: 0 – 40L
Sand: 130L (measured loose and damp)"

PSG 3.15 ALKALI-AGGREGATE REACTION

Reference is made to "Fulton's Concrete Technology, Chapter 10, Alkali-silica reaction."

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)

Result of SANS 6245 Coarse aggregate test (@12 days)	**Description**	**Limit on total active alkali content of mix (kg/m^3)**
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 of 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/m^3."

PSG 4 PLANT

PSG 4.1 GENERAL

Add the following subclause:

"PSG 4.1.1 Minimum Plant

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.

When 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. When sections of the roof and floor have to be redesigned to accommodate the crane, the redesign cost shall be borne by the Contractor."

PSG 4.5 FORMWORK

PSG 4.5.1 Design

Add the following:

"All formwork or scaffolding (referred from here on as temporary works) required for any part of the Works shall be designed by the Contractor. 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. Evidence of each of these processes through sign-off of the designs, inspections and approval of erection shall be submitted to the Employer's Agent throughout the project.

Before commencing with the erection of any temporary works, the design shall be submitted to the Employer's Agent for review and record-keeping. The Employer's Agent will not be responsible for approving temporary works since this remains the responsibility of the Contractor (via the appointment of a competent person). The Employer's Agent will however have the authority to order alterations to the design or sizes of any part of the temporary works. The

Contractor shall check the safety and suitability of all alterations proposed by the Employer's Agent to ensure that all temporary works is safe and proper for the execution of the Works. The fact that the Employer's Agent has altered any part of the temporary works shall not be construed as relieving the Contractor of his responsibility with regard to the strength and stability of the temporary works."

PSG 4.5.2 Finish
Add the following:

"The finish to all exposed concrete shall be smooth and that to buried or backfilled surfaces rough."

PSG 4.5.3 Ties

Add the following:

"No plugs, bolts, ties or clamps of any description used to hold the formwork will be allowed to project into or through the concrete 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.

Alternative tie methods other than above may be proposed but must be qualified in the tender and will be subject to the Employer's Agent's approval.

The cavities left in the concrete when the tie-rod end cones are removed shall be soundly caulked 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.

On no account shall formwork be secured to reinforcing bars."

PSG 5 CONSTRUCTION

PSG 5.1 REINFORCEMENT

PSG 5.1.2 Fixing

Add the following:

"The Employer's Agent shall only inspect the reinforcing after it has been fixed in place, the formwork cleaned, cover blocks positioned and tied, before concreting commences.

Welding of reinforcing steel will not be permitted."

PSG 5.1.3 Cover

Add the following:

"The distance between pipes in the concrete and the reinforcing steel shall nowhere be less than

(a) 40 mm or

(b) 5 mm plus the maximum size of the coarse aggregate or,

(c) the cover as specified on the Drawings, whichever is the greater."

PSG 5.2 FORMWORK

PSG 5.2.1 Classification of finishes

(b) Smooth

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."

PSG 5.2.2 Preparation for formwork

Add the following:

"Construction joints shall be positioned as shown on the Drawings."

PSG 5.2.5 Removal of formwork

Replace Table 2 with the following table*:*

<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td rowspan="5">Formwork to Structural Member</td><td colspan="9">Strength Class of Cement</td></tr>
<tr><td colspan="3">CEM-1</td><td colspan="3">CEM-II-A (or blend of CEM-I with less than 20% FA/GGCS /GGBS)</td><td colspan="3">CEM-II-B, CEM-III (or blend of CEM-I and more than 20% FA/GGCS /GGBS)</td></tr>
<tr><td colspan="9">Minimum time (24 hour periods) before removal of formwork</td></tr>
<tr><td colspan="9">Weather</td></tr>
<tr><td>Hot or Normal</td><td>Cool</td><td>Cold</td><td>Hot or Normal</td><td>Cool</td><td>Cold</td><td>Hot or Normal</td><td>Cool</td><td>Cold</td></tr>
</table>

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 subclauses:

"PSG 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.

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."

PSG 5.3 HOLES, CHASES AND FIXING BLOCKS

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. Cover blocks for reinforcing and fixtures may be placed into the concrete provided that neither the strength nor any other desirable characteristic (such as the appearance) of the concrete section is affected or impaired in the opinion of the Employer's Agent.

The holes or cavities left by ferrule cones in the concrete of water-retaining structures shall be filled with an approved non-shrink grout applied strictly in accordance with the manufacturer's specifications."

PSG 5.4 PIPES AND CONDUITS

Add the following:

"All pipes passing through concrete floors, walls or slabs shall be cast into the concrete member simultaneously with the casting of the member. Openings for pipes shall only be left in concrete members when so directed by the Employer's Agent or when shown on the Drawings. Pipes shall be installed in such openings according to the details shown on the Drawings.

If water tightness is a requirement where pipes are cast into walls, floors and slabs, the Contractor shall ensure watertightness where smooth-surfaced pipes are used by using an approved method.

The cost of such method will be deemed to be included in the rates tendered for items PSG 8.9.

Openings left for pipes shall be filled with approved non-shrink grout or micro-concrete."

PSG 5.5 CONCRETE

PSG 5.5.1 Quality

PSG 5.5.1.5 Durability

Delete Table 5

Add the following:

"The exposure conditions of the water-tight concrete are classified as **"severe"**.

The maximum allowable water : binder ratio for watertight concrete shall be **0.50**.

The maximum water : binder ratio for strength concrete shall be **0.60**."

PSG 5.5.1.7 Strength concrete

Add the following:

"The concrete mixes shall be designed by an approved laboratory.

Design

The proportions of the various sizes of aggregate, cement 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 plasticising additives may be used, or instructed to be used by the Employer's Agent, to ensure adequate workability in preference to varying the proportions of water or cement.

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.

Trial mixes

"Whenever "Designed Mixes" are required by the Schedules of Quantities or Drawings, after approval of the aggregates the Contractor shall design for each class of concrete required for the Works, have trial mixes designed within the limits specified herein for 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.

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."

PSG 5.5.3 <u>Mixing</u>

PSG 5.5.3.2 <u>Ready-mixed concrete</u>

Add the following:

"Ready-mixed concrete may be used.

Should the Contractor elect to use ready-mixed concrete in the Works he shall provide a qualified technical assistant who shall check the quality of the 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.

The Contractor shall further take samples for testing from every load delivered to the Site."

PSG 5.5.5 <u>Placing</u>

Add the following:

"Concreting of the wall 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.

Pumping of concrete shall not be permitted unless approved by the Employer's Agent. For such approval, the Employer's Agent may require shrinkage tests of the concrete to meet the criteria in PSG 5.5.11. The rates for concrete will be deemed to include such testing costs.

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."

PSG 5.5.6 <u>Compaction</u>

Delete "or (if approved)…. by spading, rodding or forking" in the first sentence of subclause 5.5.6.3.

PSG 5.5.7 <u>Construction joints</u>

Add the following:

"Horizontal construction joints are permitted in structure walls in positions indicated on the drawings or approved by the Employer's Agent. Vertical construction joints in the walls are subject to the written approval of the Employer's Agent and the cost of all such vertical or horizontal construction joints will be deemed to be included in the rates for cast in situ concrete. This also applies to the preparation of concrete to form construction joints in flume walls as specified on the drawings.

The construction joints in water-retaining structures shall be made strictly in accordance with the details shown on the drawings. 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.

Should the Contractor's method of construction necessitate the placing of a construction or other joint in a position not shown on the drawings, such method of construction and position of the joint shall be approved by the Employer's Agent in writing. The cost of such joint shall be included in the tendered rates and shall include scrabbling of the concrete where steel reinforcement is continuous.

The 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 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.
For construction joints at kickers all additional costs for concrete, preparation, etc will be deemed to be included in the rates tendered for formwork and concrete in walls or sides and kicker joints or construction joints will not be measured separately. 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."

PSG 5.5.8 Curing and protection

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 properly cured (including vigorous immediate protection) 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 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 need to 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 shall be applied within 30 minutes of the stripping of formwork 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."

PSG 5.5.10 Concrete surfaces

All unformed concrete surfaces shall, except where otherwise ordered, be given a steel float finish.

Add the following subclause:

"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.

PSG 5.5.11 Watertight concrete

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; and
- Maximise the chemical resistance of the concrete to aggressive agents in the environment.
- 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 (accelerated shrinkage test):	350 μm/m
Maximum water : binder ratio:	See PSG 5.5.1.5
Minimum cementitious binder content:	300kg/m^3
Maximum cementitious binder content:	380kg/m^3
Maximum water content:	185 litres/m^3
Maximum alkali content:	See PSG 3.15
Maximum thermal coefficient of expansion for concrete:	12x10^{-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)	30% - 50% (GGBS) 20% - 30% (FA)

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 (Item PSG8.4.3).

The following structures shall be considered water retaining/excluding and shall require watertight concrete:

- All reservoirs (including columns and roofs) and reinforced concrete valve-chambers

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."

Add the following subclauses:

"PSG 5.5.16 <u>Applied loads</u>

No crushed-stone covering or any other loads shall be placed on the roof of the structure before the concrete has attained its design strength, unless approved supports are provided."

PSG 5.5.17 <u>Pipes and conduits</u>

All pipes passing through concrete floors, walls or slabs shall be cast into the concrete member simultaneously with the casting of the member. Openings for pipes shall only be left in the concrete members when so directed by the Employer's Agent or when shown on the Drawings. Pipes shall be installed in such openings according to the details shown on the Drawings.

If watertightness is a requirement where pipes are cast into walls, floors and slabs, the Contractor shall ensure watertightness where smooth-surfaced pipes are used by using an approved method prior to casting in. The cost of such method will be deemed to be included in the rates tendered for item PSG 8.9.

PSG 5.5.18 <u>Soilcrete</u>

Where soilcrete is specified for filling, the soilcrete shall comply with the requirements of subclause PSDB 3.5 (d) of SANS 1200 DB and shall be placed as specified in the subclause.

PSG 5.5.19 <u>Brickwork</u>

Brickwork shall be carried out as specified for manholes in subclause 5.6.4 of SANS 1200 LD using bricks conforming to the requirements for bricks as per subclause 3.5.1 of SANS 1200 LD.

Brickwork shall be built in stretcher bond to the dimensions shown on the Drawings. All bricks shall be well soaked in water immediately before being laid and the previous course of bricks shall be well wetted before the laying of the following course.

PSG 5.5.20 <u>Plasterwork</u>

Plasterwork shall consist of a single coat, comprising one application of a 1 : 4 cement : sand mixture with a wood float finish. The thickness of the plaster shall be between 13 and 20 mm. All plaster shall be finished smooth, shall be plumb and corners shall be rounded and square.

PSG 5.5.21 <u>Granolithic screed/benching</u>

Granolithic concrete shall consist of 1 part of cement, 1,5 parts of sand and 3 parts of 9,5 mm maximum size aggregate by volume. In all other respects it shall comply with the specifications clauses for concrete.

The contact surface of the base concrete shall comply with the requirements for a Degree of

Accuracy II finish.

Immediately before placing the granolithic concrete, the base concrete shall be thoroughly cleaned by scrubbing, all the standing water then removed, and a 1:3 cement mortar grout of thick cream consistency well brushed into the prepared surface, the granolithic concrete shall then be applied before the cement grout sets. The granolithic concrete shall not have a slump exceeding 50 mm.

It shall be brought true to profile as shown on the Drawings with a Degree of Accuracy I finish.

PSG 6 TOLERANCES

PSG 6.2 PERMISSIBLE DEVIATIONS

PSG 6.2.3 Specified permissible deviations

Add the following:

"Degree of Accuracy II is applicable, except where specifically shown 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."

Replace Clause 6.2.3(a)(3) with the following:

	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
"Cover to reinforcement (see (e) below)..........................	-0+20	-0+10	-0+10

Replace Clause 6.2.3(d)(5) with the following:

	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
"Vertically, per metre of height	5	3	2
subject to a maximum of	50	30	10”

Add the following:

“(h) Floors

The maximum permissible deviation from a 3 m long straight line connecting two points on the surface of the finished floor is ± 3 mm.

PSG 7 TESTS

PSG 7.1 FACILITIES AND FREQUENCY OF SAMPLING

PSG 7.1.1 Facilities

Add the following:

"The Contractor shall provide sufficient storage capacity for the concrete test cubes and shall arrange to have them tested by an approved laboratory.

The cost of all testing, including the cost of sampling, storage and the transport of samples shall be included in the rates tendered for concrete work."

PSG 7.1.2 Frequency of sampling

Notwithstanding the requirements of this subclause, the Contractor shall take note that he is responsible for taking an adequate number of tests to ensure that the concrete being used complies with the specification. The Employer's Agent will only carry out such control testing as he may require.

PSG 7.3 ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE

Add the following:

"Test results obtained from the supplier of ready-mixed concrete will not be accepted for evaluation in terms of Subclause 7.3. Samples for testing shall be taken of such concrete at the point of placing.

The rates of sampling and testing will be selected by the Employer's Agent depending on the magnitude of the Works and daily pours. At least one sample (sufficient for 6 cube moulds) shall be taken from each day's casting and from randomly selected daily batches to represent an average volume of not more than those given in the table below. Each sample shall be taken from one particular batch.

Rate 1 Highly Stressed Structure	Rate 2 Ordinary Structure	Rate 3 Mass Concrete
10 m^3 or 10 batches	20 m^3 or 20 batches	50 m^3 or 50 batches
Whichever is the lesser volume		

Unless otherwise agreed by the Employer's Agent tests shall be carried out in an approved laboratory and certified copies of all test results shall be submitted to the Employer's Agent immediately after the test.

Compliance with the specified characteristic strength will be judged by tests made on cubes at an age of 28 days. Tests shall also be made at 7 days.

Not more than 5 % of the tests shall fall below the specified strength.

The average strength determined from any group of three consecutive test cubes shall exceed the specified strength by not less than 7,5 MPa.

Each individual test result shall be greater than 85 % of the specified strength.

When the average strength of three consecutive test cubes fails to meet the second of the above requirements, the mix proportions of subsequent batches of concrete shall be modified to increase the strength.

Where durability and impermeability are prime considerations, the Employer's Agent may order the density of wet concrete to be measured regularly as a check on the concrete mix. This shall be done by placing a sample of concrete being poured in a standardised container, compacting by vibration and then determining the density.

The Employer's Agent may also order tests on the hardened concrete in the structure. These may include non-destructive methods or the taking of cored samples.

In evaluating test results, the Employer's Agent will take the following into consideration:-

(i) The validity of test results.
(ii) Confirmation that specimen sampling and testing has been carried out in accordance with BS 1881.2
(iii) The mix proportions actually used in the concrete under investigation.
(iv) The actual section of the structure represented by the test cube/s.

(v) The possible influence of any reduction in concrete quality on the strength and durability of the affected section of the structure.

The Employer's Agent may thereafter declare the concrete to be defective and order action to be taken as specified."

Add the following subclause:

"PSG 7.3.6 <u>Disinfection of Structure</u>

Before testing for watertightness, the reservoir shall be thoroughly cleaned out, pressure sprayed and washed down with clean water and thereafter with the disinfect solution.

The roof soffit, beams, columns and walls shall be thoroughly sprayed down and the floor scrubbed with the solution specified in subclause 5.10 of SANS 1200 L.

On completion of the disinfection, the disinfectant solution shall be run to waste before the reservoir is filled for testing for watertightness. Disinfection is to be witnessed and approved in writing by the Employer's Agent before watertightness testing may commence.

Should any further work be necessary in the reservoir after testing, the reservoir shall be disinfected at the Contractor's expense."

Add the following subclause:

"PSG 7.3.7 <u>Testing structure for watertightness</u>

Water (potable) for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structure. Such water will not be available by means of the newly installed inlet pipework for each reservoir.

The cost of purchasing and transporting the potable water required for testing shall be covered separately under a provisional sum allowance in Section 1 Item 3.2. Upon agreement and instruction of the Employer’s Agent, the Contractor is to take measures to fill the reservoirs with potable water by carting of water from an alternative source (Mthatha furthest), using a minimum 10kl size water truck. The Contractor shall ensure that potable water is in no way compromised during the pumping/transportation.

The method of filling the reservoir with potable water is to be approved by the Employer’s Agent. Any drop in water during the stabilisation period that requires topping up of the reservoir is to be included in the provisional sum allowance. Any costs to refill the reservoir due to leaking or retesting of the structure after repair is for the Contractor’s account.”

The structure shall be filled with water at a uniform rate not exceeding 2,0 m in 24 hours until the top water level has been reached. The water level will then be carefully noted and recorded by the Employer’s Agent in relation to a fixed benchmark, and the water level 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 and rainfall, if applicable, shall not exceed 1/500th of the average water depth of the full tank, or 10 mm.

Should the structure not satisfy the 7-day test, then, after the completion of remedial work, it shall be refilled if necessary, left for a further stabilisation period, a further test of 7 days duration shall then be undertaken in accordance with this clause.

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. It is noted that leaking cracks that do not self-heal in the stabilisation period will be considered defects in the test and will require suitable/approved repair.

The costs of emptying the 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 utilise the water if he so desires.

The water shall further not be used as a medium for additives to effect remedial work or to stop leaks.

The costs of retesting the structure for watertightness shall be borne by the Contractor, including the cost to obtain water required for such retesting.

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.1 MEASUREMENT AND RATES

PSG 8.1.1 <u>Formwork</u>

Delete “or splays over 20 mm x 20 mm” from the first line of paragraph 8.1.1.2.

Add the following to paragraph 8.1.1.2:

“Splays up to and including 25 mm x 25 mm will not be measured separately and will be deemed to be included in the formwork costs.”

Add the following paragraphs:

“8.1.1.7 For construction joints at kickers, all additional costs for formwork to edges up to 300 mm high 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 No formwork will be measured to edges of blinding layers under structures, and the cost thereof (if needed) will be deemed to be included in the rates tendered for concrete in blinding layers.

8.1.1.9 Back-shuttering or formwork to top revealed surfaces of sloping or conical formwork will only be measured to surfaces of over 40° and up to 85° to the horizontal.

8.1.1.10 Formwork to horizontal surfaces in reservoirs, chambers, manholes or sumps can 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.”

PSG 8.1.2 Reinforcement

Replace the contents of this Clause 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 shall be calculated from the net area covered by the mesh, excluding overlaps.

Clips, ties, separators, stools and other steel used for positioning reinforcement will not be measured, unless these are shown on the bending schedules.

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."

PSG 8.1.3 Concrete

Add after “mixing, testing” in the second line of subclause 8.1.3.3(a) “including transport to an approved laboratory,”

Add the following to PSG 8.1.3.3(a):

The tendered rate for walls shall also include for forming vertical joints where authorised.”
Delete “, or the plan size of the excavation where additional excavation is provided to facilitate erection of forms” from the second line of paragraph 8.1.3.1(c).

Add the following to PSG 8.1.3.1(d):
"Strip foundations and encasement of pipes shall be cast directly against the sides and bottoms of excavations.

No payment shall be made for additional concrete in overbreak."

PSG 8.2.5 Narrow Widths

Add the following:

"Widths in excess of 300 mm shall not be regarded as narrow widths."

PSG 8.2.6 Box out holes / Form voids

Replace the heading of item (d) with the following:

"Large other than circular, of area over 0,1m² up and including 5m²."

PSG 8.4 SCHEDULED CONCRETE ITEMS

PSG 8.4.3 Strength Concrete, Grade

Replace "Unit: m^3" with "Unit: m^3 or m²"

Add the following after the last sentence:

"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."

PSG 8.5 JOINTS

Replace "Unit: m" with "Unit: m or m²".

"PSG 8.9* Inserts (type of description stated) ……………………………………………Unit: No

The tendered rate shall cover the cost of taking delivery, installing and fixing in position as detailed, for splitting and cutting the formwork where required, dealing with the reinforcement, ensuring watertightness and casting into concrete of the scheduled items and shall further include all clearing and cleaning preparation as well as for finishing.

Pipes for casting into concrete will be measured elsewhere.

The provision of the items to be built in and fixed will, except if otherwise stated, be measured for payment elsewhere."

PSG 8.11 BRICKWORK Unit: m²

Separate items will be scheduled for brickwork of different thicknesses and classes.

The unit of measurement shall be the nett area (on elevations) of brickwork constructed to the specified thickness, measured in square metres.

The tendered rate shall include full compensation for constructing the brickwork as specified including the provision of all materials and cleaning up on completion of the work.

PSG 8.12 PLASTERWORK:

(a) Plaster (state thickness) Unit: No
(b) Fillets, skirtings, etc (state dimensions) Unit : m

The unit of measurement for subitem (a) shall be the nett area of plasterwork constructed to the specified thickness, measured in square metres or for subitem (b) the nett length of corner filters, skirtings, etc constructed to the specified dimensions, measured in linear metres.

The tendered rate shall include full compensation for constructing the plasterwork including the supply of all materials, mixing, applying, finishing, rounded corners and all else that may be required to complete the work as specified.

PSG 8.13 SCREEDS:

(a) 1:3 floor screeds with falls including V-joints to form panels and a smooth steel trowelled finish/power float finish to top:

(i) Description of application and thickness Unit: m^2
(ii) Etc for other applications and thicknesses

The unit of measurement shall be the square metre of screeds constructed.

The tendered rate shall include full compensation for constructing the screeds as specified including the supply of all materials, preparing the concrete surface to receive the screeds and for all else that may be necessary to complete the work.

PSG 8.14 CAST IN OF PIPES WITH OR WITHOUT PUDDLE FLANGES:

(a) Up to 300 mm nominal bore:

(i) Through (description and thickness of structure elements) Unit: No.

(b) Over 300 mm up to 600 mm nominal bore:

(i) Through (description and thickness of structure elements) Unit: No.
(ii) Etc for other nominal bores in increments of 300 mm

The unit of measurement shall be the number of each size of pipe installed.

The tendered rates shall include full compensation for installing the pipe where new pipes are used (with or without a puddle flange) in the exact position as shown on the drawings, for splitting or cutting the formwork where required, for ensuring watertightness where required and for all additional costs required to install the pipes specified or shown on the drawings.

New pipes shall be measured under the items of the relevant section of the specifications.
“PSG 8.15* ALTERNATIVE METHODS OF FILLING OF STRUCTURES FOR WATERTIGHTNESS TESTING

(a) (Structure stated) Unit: No.

The unit of measurement shall be the number of each structure successfully disinfected and filled to the TWL and maintained (refilled if necessary, as per the watertightness test) at that

TWL during the stabilisation period and passing the specified watertightness tests to the satisfaction of the Employer's Agent.

The sums tendered shall cover the cost of all labour, plant and materials to disinfect, fill the reservoir and keep it filled during stabilisation as well as for the disposal of the disinfectant. The tendered rate shall however not include the cost to procure and cart water from Mthatha (furthest). A provisional sum allowance has been made for the purchasing and carting of water under BOQ Section 1 Item 3.2.

Any costs to refill the reservoir due to leaking or retesting of the structure after repair is for the Contractor's account."

PSHA STRUCTURAL STEELWORK (SUNDRY ITEMS)

PSHA 3 MATERIALS

PSHA 3.1 STRUCTURAL STEEL

Add the following:

"Where stainless steel is to be used, the grade shall be 316 or as shown on the Drawings."

PSHA 5 CONSTRUCTION

PSHA FABRICATION AND ASSEMBLY

PSHA 5.2.2 Cutting

Add the following:

"The edges of flame-cut plates shall be ground smooth."

PSHA 5.2.4 Welding

The Contractor shall submit with his shop Drawings full details of welding procedures. All welds shall be continuous.

Unless otherwise approved no longitudinal or overhead welding shall be carried out on site. Under no circumstances will cutting and welding of grid covers and frames be permitted on site.

Welders undertaking manual welding of permanent steelwork shall be experienced and competent artisans.

PSHA 5.2.7 <u>Ladders</u>

Replace the heading of with "<u>Ladders and Step Irons</u>"

Add the following:

"Ladders and step irons shall be of stainless steel grade 316 as specified."

"PSHA 5.2.8.3* All open grid floors and frames shall be stainless steel grade 304 as detailed. All open grid floor panels shall be open-ended as specified, except where bonding is specified on the Drawings. Cut outs shall be provided where indicated on the Drawings"

PSHA 8 MEASUREMENT AND PAYMENT

PSHA 8.3 SCHEDULED ITEMS

Replace the heading of subclause 8.3.1 to read:
"PSHA 8.3.1 <u>Structural steel for:</u> (Type of structure indicated) ……………………. Unit: t, No or Sum"

Add the following after the last sentence of subclause 8.3.1:

"Alterations to existing structural steelwork will be described in the schedule and measured in number. Rates for these items shall include full compensation for all labour tools, storing, additional steelwork, reinstallation, cleaning

“PSHA 8.3.3 Ladders, complete and installed…………………………………. Unit: No”

Add the following:

“Separate items will be scheduled for ladders of different materials, dimensions and height.

PSL MEDIUM PRESSURE PIPELINES

PSL 3 MATERIALS

PSL 3.1 <u>GENERAL</u>

Add the following paragraphs:

"Each type of pipe delivered to the Site shall have a standard length corresponding with the standard lengths offered by the pipe manufacturer in his catalogue, with a maximum permissible variation in length of ± 2%.

A pipe that is a shorter or longer than the defined standard will be rejected by the Employer's Agent, except when such non-standard lengths are required in terms of the Contract and have been specifically manufactured or cut as such by the pipe manufacturer or supplier."

PSL 3.4 STEEL PIPES, FITTINGS, AND SPECIALS

PSL 3.4.2 <u>Pipes of nominal bore up to 150 mm</u>

Add the following:

"The pipes shall be 'normalised' or seamless steel pipes and shall be used with malleable cast-iron fittings complying with the requirements of SANS 14.

Where flanges are required, they shall comply with SANS 1123 table 1600 unless otherwise indicated on the Drawings."

PSL 3.7 OTHER TYPES OF PIPES

Replace the heading and contents of subclause 3.7.1 with:

"PSL 3.7.1 <u>uPVC pipes and fittings</u>

uPVC pipes and fittings shall be provided with spigot and socket rubber ring joints and shall comply with SANS 966-1 and shall carry the SABS mark. Solvent welded fabricated fittings will not be acceptable.

"PSL 3.7.2 <u>Polyethylene pipes and fittings</u>

"Polyethylene pipes shall be black HDPE type IV pipes and shall comply with SANS/ISO 4427 and shall carry the SABS mark, manufactured from PE80 or PE100 material with a nominal pressure rating (PN) as indicated on the Drawings and scheduled in the Bill of Quantities.

The HDPE pipes shall be joined together by means butt-welded joints. Where HDPE pipes is to be connected to steel flanges, this shall be done with HDPE stub-flange, supplied with gasket and grade 316 stainless steel backing ring and fasteners.

Compression fittings to be used with HDPE pipes and shall be "Plasson", "Alprene" or approved equivalent with a nominal pressure rating (PN) as indicated on the Drawings and scheduled in the Bill of Quantities."

"PSL 3.7.3 <u>mPVC pipes and fittings</u>

mPVC pipes and fittings shall be provided with spigot and socket rubber ring joints and shall comply with SANS 966-2 and shall carry the SABS mark. Solvent welded fabricated fittings will not be acceptable."

"PSL 3.7.4* Copper tubing and fittings

Copper tubing shall be class 0 and comply with the requirement of SANS 460. Fittings shall be brass "Conex" compression fittings to SANS 1067 and shall carry the SABS mark."

PSL 3.8.3 Flanges and accessories

Add after "insertion piece" in the second line "consisting of a full face gasket".

Notwithstanding the provisions of this clause, Flanges shall comply with SANS 1123 or BS EN 1092 unless required to match existing flanges. Raised face flanges shall be provided for pipework of PN 25 and higher. Flange drilling shall be "off centre" unless required to match an existing flange which is drilled otherwise. The jointing material used on flanged joints shall be of a suitable rubber or compressed mineral fibre at least 3mm thick complying respectively with BS EN 681 or BS EN ISO 23936, as applicable. Gaskets shall be full face. Properly designed O-ring seals are also acceptable subject to receiving approval from the Employer's Agent.

All fasteners, including studs welded to flanges, shall be of stainless steel grade 316 and shall comply with EN ISO 3506-44, as applicable.

All pipes, specials and fittings shall be supplied complete with all necessary stainless steel grade 316 bolts, washers and nuts as well as appropriate full face insertion pieces, applicable to diameter and material.

PSL 3.8.4 Loose flanges

Bolts and nuts shall comply as stated in PSL 3.8.3.

Add new subclause

"PSL 3.8.8* Orifice Plates

Orifice plates shall be manufactured from 10mm thick grade 316 stainless steel and shall be inserted between flanges where it is stated in this document and or the Drawings that orifice plates are required. The orifice shall be sharp edged, double bevelled, with a 4mm edge and shall be manufactured by an approved supplier."

PSL 3.9 CORROSION PROTECTION

PSL 3.9.1 CI pipes

"Notwithstanding the provisions of this subclause, all CI pipes, fittings, specials, valves, meters and hydrants shall be coated internally and externally using "Rilsan" or equivalent to a dry film thickness of at least 200 micron. The coating shall be applied by an approved applicator. Fusion bonded epoxy (FBE) coating applied internally and externally to SANS 1217 or DIN 30677 will also be accepted".

PSL 3.9.2 Steel pipes

PSL 3.9.2.1 Steel pipes of nominal bore up to 150 mm

Add the following:

"Steel pipes utilised for the air vent shall be galvanised only as shown on the Drawings. Steel pipes, fittings and flanges within the chambers shall be hot dip galvanised and FBE coated after fabrication, in accordance with the requirements of SANS 32 for heavy duty applications. Further machining, cutting or welding after hot dip galvanizing will not be allowed. Fusion bonded epoxy (FBE) coating shall comply with the provisions of SANS 1217 or DIN 30677 will also be accepted"

PSL 3.9.2.2 Steel pipes of nominal bore over 150 mm

Add the following:

"Steel pipes shall be hot-dip galvanised where shown on the Drawings and as specified in sub-subclause 3.9.2.1. The hot-dip galvanising shall comply with the requirements of the hot-dip galvaniser's Association of South Africa"

PSL 3.9.6 <u>Corrosive soil</u>

Add the following:

"Where shown on the Drawings, steel pipes in contact with corrosive soil shall be wrapped with Densopol 80 HT or an equivalent approved product, strictly in accordance with the manufacturer's instructions."

PSL 3.10 VALVES

Replace the contents of this subclause with the following:

"Definition of valves will be deemed to also include water meters and Prefabricated Break Pressure Tanks (BPTs).

Valves shall comply with the following requirements in addition to the Specification per valve type detailed below.

- Meet a minimum Pressure Class of 25 bar and or the pressure class as stated in the BOQ, in cases where the BoQ does not specify a pressure class, it shall be taken as 25 Bar.
- They shall be complying with SANS 664/1974 with pressure class as per the Drawings and Bill of Quantities.
- They shall comply with the requirements of SANS 1123 and further specified in this Specification and Bill of Quantities.
- Valves shall be coated before delivery, both internally and externally with a suitable bitumastic paint free of phenols."

PSL 3.10.1 <u>Gate Valves</u>

<u>The following type of gate valves shall be used on this project as measured in the Bill of Quantities</u>

- Flanged gate valves with spindle cap or handwheel (AVK Series 43/60 RSV valves or approved equivalent)

- Flanged Gate Valve with spindle cap (AVK Series 06/40 or approved equivalent)
- Flanged Gate valve with handwheel (AVK Series 06/40 or approved equivalent)
- Socketed gates valves for uPVC pipes shall be AVK Series 01/60 RSV valves or approved equivalent
- Class 8 "Prestex" (Cobra) or similar approved cast brass full way gate valves complying with SANS 776-1975 shall be used. The valves shall be fitted with non-rising spindles and guided wedges and shall have taper threaded female end connections.

A valve shall be provided with double flanged or double spigoted or double socketed end connections, as billed. Unless otherwise billed, it shall be supplied complete with all jointing material such as insertions, rings, packings, bolts, nuts and washers etc. as necessary for the type of connection billed.

PSL 3.10.2 Air valves

The following type of valves shall be used on this project as measured in the Bill of Quantities

- Three pieces full-bore stainless-steel ball valve
- Three stage double orifice air release and vacuum break valve (Vent-o-Mat model RBX or similar approved air valve)

The valves shall further be as specified on the Drawings and in the Bill of Quantities in terms of size, connection type, pressure rating and model number.

Each air valve shall be supplied with:

i) a bronze isolation cock, (for DN 25 valves only), and
ii) flanged isolating RSV gate valve as specified in this document, and with or without bevel gears and spindle cap or handwheel as specified
iii) three-piece full-bore stainless-steel ball valves with PTFE seats as supplied by Vac-Cent Services, or approved equivalent. The maximum working pressure of 16 bars.

Each double or multiple orifice air valve (flanged) shall be fitted with a suitable drain cock to release the pressure inside the valve when the isolating valve is closed at a time when the float is sealing the large orifice.

Double and Triple orifice air valves shall be provided with cast iron shield plates so designed as to prevent the entry of dirt when the large orifice is open.

PSL 3.10.3 Water Meters

The meter on the outlets of the reservoirs and the Main Supply shall be 50mm - 250mm “Kent Helix 4000”, combination bulk water meter or approved equivalent with flanges to suit PSL 3.8.3.

For the village reticulation / standpipes, the water meter shall be the 165mm long x 15mm VT110T KSM meter or similar approved RDP standard standpipe water meter.

Flanged end connections shall comply with SABS 1123 for a nominal pressure corresponding to that of the water meter and the stated working pressure of the adjacent pipework.

The meter design shall provide for a reasonable clearance behind the rear face of flanges to allow access to e.g. bolts and nuts for installation and removal. The flow rate shall be between

0.35m3/h – 2000m3/h and the maximum working pressure of 16 bars. The accuracy of the meter shall be guaranteed equal or better than ± 0.5% of the measured value.

PSL 3.10.4 Check valves

Check valves shall be AVK Series 53/35 or similar approved resilient seated ball check valves. The ball shall be ductile iron, vulcanised with NBR rubber and shall be of the full-bore type. It shall be externally and internally coated with epoxy coating to DIN 30677. The valve shall further be pressure rated to 20 bar.

The valve shall be suitable for horizontal or vertical mounting, of robust construction, and shall close drop tight at the required operating head. Access to the moving parts shall be possible without removing the valve from the line. In addition, the following shall apply:

a) For flanged check valves:
   i) the valve shall be double flanged;
   ii) the body, cover and door shall be of close-grained cast iron;
   iii) the door shall be fitted with a zinc-free phosphor-bronze face closing on a corresponding bronze face in the body, and
   iv) the door suspension lugs shall be hinged on a long zinc-free, phosphor-bronze spindle supported in trunnion bearings on both sides of the body;

b) For wafer type spring check valves:
   i) the discs shall be either stainless steel or carbon steel with resilient seats, and

   ii) the valve bodies shall be manufactured of the materials specified.

PSL 3.10.5 Control valves

The following type of level and flow control valves shall be used on this project as measured in the Bill of Quantities

For the reservoirs, the following control valves shall be used

- Bermad WW-EN-750-03-66-3Q-Y-C-16-EB-PB-F or similar approved, flow control with Bi-Level and Anti-Surge Closing
- DN50 Equilibrium (ball) float control valves, PN16, with flanged end, or similar approved.

PSL 3.10.6 Prefabricated Break Pressure Tanks (BPTs)

The following type of BPT shall be used on this project as measured in the Bill of Quantities

The LW Tank Systems Prefabricated stainless steel BPTs or similar approved shall be used. The model numbers for the BPTs to be used as below.

- LWTS-50-BPT-01 or similar approved
- LWTS-80-100-BPT-01 or similar approved

PSL 3.11.1 Bricks

Bricks complying with the details shown on the Drawings and Bill of Quantities shall be used.

PSL 3.11.4 Step irons

Step irons complying with the details shown on the Drawings shall be used.

PSL 3.11.5 Manhole covers and frames

The requirements of the subclause shall apply, except that the type of cover and frame to be used shall be as detailed on the Drawings.

PSL 3.11.6 Surface Boxes

All surface boxes, including air, scour and inlet chambers shall be as specified and detailed on the Drawings.

PSL 3.13 PROTECTION DURING STORAGE, HANDLING AND CONSTRUCTION

The Contractor shall satisfy the Employer's Agent that the manufacturer's recommendations for good practice for the transporting, handling, stacking, storing and installing of pipes, pipe fittings, seal rubber etc. are being diligently followed. The Employer's Agent's Representative shall be given the opportunity to inspect all materials immediately upon delivery and prior to installation and shall have the right to reject any materials which, in his or her opinion has / have suffered damage which may impair the long-term durability and or strength of said items.

Pipes and specials shall be protected against damage during all stages of manufacture, delivery, storage and handling.

PSL 5 CONSTRUCTION

PSL 5.1.1 General

Add the following to Clause 5.1.1:

"PVC pipes shall be laid, cut and jointed strictly in accordance with the manufacturer's instructions. A pipeline shall further be laid continuously; the leaving of gaps for fittings will not be permitted.

Where applicable, pipes to be laid in a combined trench shall further be laid so that their joints are directly opposite one another and so that all pipe markings printed on the pipes are positioned at the top."

PSL 5.1.4 Depths and cover

Notwithstanding the requirements of this Subclause, the pipeline shall be laid to the levels shown on the Drawings or as ordered by the Employer's Agent.

Add the following new subclause under PSL 5.1.4

"PSL 5.1.4.6* Position of spindle of gate valves

The top of the spindle of a gate valve shall not be less than 75 mm nor more than 600 mm below the level at which the soffit of the valve box is to be set. To ensure the aforementioned, valve spindle extension pieces shall be fitted by the Contractor, complete with stabilisers, where required."

PSL 5.6 VALVE AND HYDRANT CHAMBERS

PSL 5.6.1 General

Replace the words "drawing L-1" *in the second line with* "the Drawings".

PSL 5.6.2 Construction of chambers

Replace the words "drawing L-1, L-2 and L-3" *in the fourth line with* "the Drawings".

Add the following subclauses:

"PSL 5.11 STANDPIPES

Standpipes shall be erected in the positions and to the details shown on the Drawings.

PSL 5.12 MARKER BLOCKS

Type 1 and Type 2 marker blocks shall be manufactured and positioned as shown on the Drawings.

PSL 5.13 PIPELINE ROUTE MARKERS

Route markers for the various water pipelines shall be erected in the positions and shall be manufactured according to the details shown on the Drawings."

PSL 7 TESTING

PSL 7.3 STANDARD HYDRAULIC PIPE TEST
PSL 7.3.1 **Test pressure and time of test**

PSL 7.3.1.2 The maximum working pressure for the different pipes is indicated by the class of the pipe.

PSL 8 MEASUREMENT AND PAYMENT

PSL 8.1 GENERAL

Replace the second sentence of this Clause with the following:

“No payment will be made for depths of excavation in excess of those specified unless ordered in writing by the Employer’s Agent.”

PSL 8.2 SCHEDULED ITEMS

PSL 8.2.1 Supply, lay and bed pipes complete with couplings
Unit: m

Add the following:

“The rate tendered shall further cover the cost of the work provided for under 8.2.4, for the supply and installation of all stainless-steel bolts, nuts, washers, insertion pieces, for corrosion protection as specified, and with respect to testing, for the supply and installation of all equipment, fittings and specials required, as well as the cost of water drawn and the disposal of the sterilisation solution. The measured quantity of pipe length will not, except for the payment of materials on site, be measured for payment until the length under consideration has been accepted in terms of subclause 7.3, PSL 7.3.1 and 7.3.3.

"The Contractor shall be responsible for all costs associated with obtaining water for pressure testing of the pipelines. Programming of the testing and commissioning of the scheme should be performed such that once watertightness testing of the reservoirs has been successfully completed, the water inside the reservoirs can be used to test and commission the installed pipelines. No additional provision or payment will be made for water required for testing the pipelines.
The contractor would be required for testing /commissioning/repairing work done by others and accept responsibility/liability for the work done by others following his testing.

The Contractor will be allowed to claim the following percentages for interim payment purposes as the various activities are completed:

Stage of Completion	**Percentage Applicable**
Pipes laid, fully bedded and backfilled in trench	85.00%
Pipes cleaned, disinfected and tested successfully.	100.00%

Note that the percentage applicable is given in the above table as a cumulative figure."
PSL 8.2.2 Extra over 8.2.1 for the supplying, laying and bedding of specials complete with couplings .... Unit: No

"<u>Tees</u>

Specials will be measured by number, extra over the cost of the installation of the pipes. The tendered rate shall include the supply, lay, bedding, jointing and testing of the specials.

The tendered rate for specials shall be held to include machine collars (where required) on the specials and the couplings / welds necessary to fit the special to the associated pipeline and one set of bolts, nuts and gaskets per flanged special.

Mechanical couplings shall be measured separately by number. The tendered rate shall also include for petroleum mastic and tape wrapping where mechanical couplings and flanges are buried.

<u>Bends</u>

Bends will be measured by number, extra over the cost of the installation of the pipes. The tendered rate shall include the supply, lay, bedding, jointing and testing of the bends. The tendered rate shall also include the cutting of pipes, preparation of pipe ends and repair of corrosion protection (where required)"

PSL 8.2.3 Extra over 8.2.1 for the supplying, fixing and bedding of valves .... Unit: No

Add the following:

"The rate tendered shall also as applicable cover the cost of the provision of corrosion protection as specified as well as the supply and installation and testing of all stainless-steel bolts, nuts, washers, insertion pieces, as required."

PSL 8.2.4 Extra over 8.2.1 for the cutting of the pipe and the supplying and fixing of the extra coupling

Delete this Clause:

Provision has been made under PSL 8.2.1 for the measurement and payment of work included under this Sub-Clause.

PSL 8.2.11 Anchor blocks/Thrust blocks and pedestals

Insert "concrete" *before* "and" *in the last line of the last paragraph*.

REPLACE THE LAST SENTENCE OF SUBCLAUSE 8.2.11 WITH THE FOLLOWING:

"Where measured by number or sum, the rate or sum shall cover the cost of excavation, trimming, backfilling, concrete, formwork, and steel reinforcement (including 80 kg high tensile steel per cubic metre of concrete where the amount of steel is not indicated on the drawings) as well as labour, etc., to complete the thrust block as shown on the drawings in addition to the operations and materials specified in this subclause."

Replace the heading and contents of subclause 8.2.13 with the following:

PSL 8.2.13 Chambers

a) <u>Valve and Meter Chambers, etc.</u> .... Unit: No

REPLACE THE SECOND SENTENCE IN SUBCLAUSE 8.2.13 (a) WHICH STARTS WITH THE WORDS “The rate shall cover …” WITH THE FOLLOWING:

"The rates for valve chambers and other pipeline structures shall cover the costs specified for thrust blocks and for all other necessary materials, such as air vents, access covers and access ladders to complete the chamber as detailed on the drawings, but excluding:

i) reinforcing steel, and

ii) pipe specials (valves and fittings).

The rates shall also cover the costs of providing padlocks to all chambers, opened by the same master key."
b) <u>Extra over for chambers of depth exceeding 1,5m</u> .... Unit: No

Additional depths of chambers in excess of 1,5m will be measured in increments of 0,5m depth for each type of chamber.

The rate tendered shall cover the cost of the complete construction of each extra 0,5m additional depth as well as for additional step irons as required.

<u>Note:</u>

The Contractor shall note that all pipes, specials and fittings in the various valve chambers along the route of the pipeline have been grouped together in the Bill of Quantities and not separately itemised per Sub-Clauses 8.2.2 and 8.2.3. The payment provisions as specified shall none the less apply as appropriate.”

PSL 8.2.15 Special Wrapping in Corrosive Soil

Delete this subclause. Provision has been made under PSL 8.2.1 for the measurement and payment of work included under this Sub-Clause.

Add the following new Clauses:

PSL 8.2.16* Marker blocks

(a) Installation of valve markers complete as per Drawing ....Unit: number

(b) Installation of pipe markers complete as per Drawing ………………………... Unit: number

(c) Installation of road crossing markers complete as per Drawing……………… Unit: number

The tendered rate shall include full compensation for all excavation and backfill, labour, equipment and materials to manufacture and install the blocks as shown on the Drawings.

PSL 8.2.17* .... Supply and install overflow, scour, inlet and outlet pipes at reservoir (description, diameter, and material type specified) Unit: Number

The rate tendered shall cover the cost of the work provided for under 8.2.1, PSL 8.2.1 and 8.2.4, for the supply and installation of all stainless steel bolts, nuts, washers, insertion pieces, for corrosion protection as specified, and with respect to testing, for the supply and installation of all equipment, fittings and specials required, as well as the cost of water drawn and the disposal of the sterilisation solution. The measured quantity of pipe length will not, except for the payment of materials on site, be measured for payment until the length under consideration has been accepted in terms of subclause 7.3, PSL 7.3.1 and PSL 7.3.3.

PSL 8.2.18* Extra over 8.2.1, PSL 8.2.1 and PSL 8.2.17 for building in of overflow, scour, inlet and outlet pipes at reservoir .... Unit: Sum

The rate tendered shall cover the cost of all labour, materials and equipment to build in the overflow, scour, inlet and outlet into the floor of the reservoir."

PSL 8.2.19* Standpipes complete:

(a) (Give description with reference to drawing) ....Unit: number

(b) Etc for other descriptions

The tendered rate shall include full compensation for all excavations for the pipe, for the drain, if required; the base of the concrete pedestal (for the tap); the supply and installation of all pipework and fittings including a 1,2 m long section of the supply pipe measured from the rising pipe; the supply and installation of the taps; backfilling the drain with stone, and the trench with approved backfill material; all formwork and concrete, and; all equipment, labour and diverse material required to complete the standpipe as shown on the Drawings.

PSL 8.2.20* Connection to existing main supply pipe .... Unit: number

The tendered rate shall include full compensation for the cost of excavation, connection to existing 350 mm diameter main supply pipe, removal of surplus material, all labour and equipment necessary to make the connection and all liaison with the local authorities.

PSL 8.2.21* Testing, disinfecting and commissioning of work by Others .... Unit: m
Contractor shall be required to incorporate into his Works length of pipes as shown in the Drawings work done by Others and this rate shall be for the exposing, testing, disinfecting and commissioning as part of his Works pipes done by Others as indicated in the Drawings.

The Contractor shall be responsible for all costs associated with obtaining water for pressure testing of the pipelines. Programming of the testing and commissioning of the scheme should be performed such that once watertightness testing of the reservoirs has been successfully completed, the water inside the reservoirs can be used to test and commission the installed pipelines. No additional provision or payment will be made for water required for testing the pipelines.

PSL 8.2.22* Exposing and repairing work by Others Unit: m

In cases where the testing fails, this item shall be used to compensate the Contractor for exposing and repairing of Work done by others. The rate shall be for labour and plant only. The materials shall be measured under the relevant items in this Specification.

PSL 8.2.23* Supply, Delivery, Installation, Disinfection, Test and commissioning of prefabricated stainless steel Break Pressure Tanks

As per Clause PSL 3.10.6, the Contractor shall supply, deliver, install, disinfection, test and commission prefabricated stainless steel Break Pressure Tanks complete as per drawing 1005270-0000-DRG-CC-614, including galvanised inlet, outlet and overflow pipework, the valves required complete as follows.

(a) LWTS-50-BPT-01 or similar approved for 50mm - 63mm HDPE dia. pipes . Unit: number
(b) LWTS-80-BPT-01 or similar approved for 75mm - 90mm uPVC dia. pipes Unit: number
(c) LWTS-100-BPT-01 or similar approved 90mm - 250mm uPVC dia. pipes Unit: number

The tendered rate shall include full compensation for all the pipes, fittings, valves, disinfecting, watertightness testing and commissioning of BPT. The cost shall also include providing the water required for the watertightness test.

PSL 8.2.24* Extra-over item PSL 8.2.23 for the clearing, excavations, formwork and construction of the BPT bases Unit: Number

The tendered rate shall include full compensation for all excavation and backfill, labour, equipment and materials to construct the reinforced concrete base, 300mm thick, 25/19 MPa.

PSL 8.2.25* Extra-over item PSL 8.2.23 and PSL 8.2.24 for any other items not included above however critical for the installation and functioning of the BPTs Unit: Sum

The tendered rate shall include full compensation for all labour, equipment and materials required for the successful installation of the BPTs as detailed in this Specification however not included in the items above

PSL 8.2.26 Take ownership, lay, bed, test and disinfect pipes complete with couplings:
Where allowance has been made for the Contractor to take ownership of material from the Employer, lay, bed, test and disinfect, the tendered rate shall exclude the cost to procure the material, but include all other costs noted in PSL 8.2.1, as well as the costs to take ownership of the material from the Employer, performing

all necessary tests and inspection to ensure the material meets the requirements of the contract specification and transport of the material to the site.

PSLB BEDDING (PIPES)

PSLB 2 INTERPRETATIONS

PSLB 2.3 DEFINITIONS

<u>Flexible pipe</u>

Add the following:

“mPVC, HDPE and steel pipes shall all be classified as flexible pipes.”

PSLB 3 MATERIALS

PSLB 3.1 SELECTED GRANULAR MATERIAL

Replace the contents of Clause 3.1 with the following:

"Selected granular material shall have a PI not exceeding 6 and shall be free from sharp-edged particles exceeding 19 mm."

PSLB 3.2 SELECTED FILL MATERIAL

ADD THE FOLLOWING:
"Selected fill material used for bedding shall be stabilised with 5% cement as specified under Subclause PSDB 3.5(c)."

PSLB 3.3 BEDDING

Add the following:

“For the purposes of this clause mPVC, HDPE and steel pipes shall be classified as flexible pipes.”

Where structures are to be built over pipework, where shown on the drawings, or where ordered by the Employer’s Agent, the bedding cradle specified shall be stabilised with 5% cement as specified under Subclause PSDB 3.5(c)."

PSLB 3.4.1 <u>Suitable material available from trench excavation</u>

Replace the words “(but is not required”) in the fifth line with the words “(at his own cost).”

“PSLB 3.5* BEDDING IN WATERLOGGED CONDITIONS

Where ordered by the Employer’s Agent a bedding cradle of the specified thickness, comprising of 6,7 mm concrete stone complying with SANS 1083, shall be used in waterlogged conditions.”

PSLB 5 CONSTRUCTION

PSLB 5.1.1.2 <u>Bottom</u>

Add the following:

"Where expansive clay is encountered in the trench bottom, the selected fill blanket shall comprise of selected granular material."

PSLB 5.1.2 Details of bedding

Notwithstanding the provisions of this subclause, pipes shall be bedded and protected in accordance with the details shown on the Drawings, which shall supersede, as applicable, drawings LB 1 through to LB 5.

Add the following paragraph.

"The dimension "X" for flexible and rigid pipes as indicated on drawing LB-1 will be 150 mm unless otherwise indicated on the drawing. The dimension "X" will be measured from the invert of the pipe."

PLSB 5.1.4 Compacting
REPLACE "90%" WITH: "90% (100% for sand)".

PSLB 5.3 PLACING AND COMPACTING OF FLEXIBLE PIPES

Notwithstanding the provisions of this subclause, the bedding for flexible pipes shall be constructed to the dimensions shown on the Drawings and by using the bedding material specified (refer also PSLB 5.1.2).

PSLB 8 MEASUREMENT AND PAYMENT

PSLB 8.1.3 Volume of bedding materials

Notwithstanding the provisions of this subclause, the volume of bedding will be computed from the dimensions shown on the Drawings.

Replace the last sentence with the following:
"No allowance will be made for bulking of material or any additional volume of bedding material required due to over break or any other cause.

Further, the volume of bedding displaced by the pipeline will not be measured for payment."

PSLB 8.1.5 Disposal of displaced material

Replace the contents of this Clause 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 shall be payable for such material."

PSLB 8.1.6 Free-haul

Delete the words "of 0,5 km" in the first line of this Clause.

Refer to SANS 1200 D, Subclause 5.2.5 (Transport for earthworks).

PSLB 8.2.2.3 From commercial sources

(c)* 6,7 mm concrete stone to SANS 1083 .... Unit: m^3

Add the following to the end of this Clause:

“Commercial sources shall include off-site sources located by the Contractor.”

PSLB 8.2.5 Overhaul of Material for Bedding … etc.

Delete this subclause

“PLSB 8.2.6* Extra over 8.2.1 and 8.2.2.1 to screen material for:

(a) Selected granular material..Unit : m^3

(b) Selected fill material ....Unit : m^3

The tendered rate shall cover the cost of supplying all labour, plant and equipment necessary to select and stockpile suitable material, as well as for screening the material to comply with the specifications for the different types of bedding material.”
ADD THE FOLLOWING:

"PSLB 8.2.7 Provision of stone/geofabric to deal with water................................ Unit: m^3/m^2

If in the opinion of the Employer’s Agent, the Contractor complied with the requirements for dealing with water as specified in PSA 8.8.7., the Employer’s Agent may instruct the installation of crushed stone and filter fabric. Payment for these items will only be made where instruction was given in writing by the Employer’s Agent.

The provision of crushed stone bedding material will be measured by volume based on the specified trench width and a maximum layer thickness of 300 mm unless a greater depth has been specified by the Employer’s Agent.

The unit rate shall cover the cost of supplying and laying the crushed stone.

The filter fabric will be measured separately by area based on the specified trench width, a stone bedding thickness of 300 mm and an overlap of 300 mm.

The rate shall cover the cost of the supply, delivery and laying of the filter fabric.

SLE STORMWATER DRAINAGE

PSLE 1 SCOPE

PSLE 1.1 Add the following:

“This specification shall also cove the construction and installation of the subsoil drainage applicable to the reservoir.”

PSLE 3 MATERIALS

PSLE 3.4 MANHOLES, CATCHPITS, AND ACCESSORIES

PSLE 3.4.1 Bricks

ADD THE FOLLOWING:

"Bricks shall be engineering bricks complying with the requirements of SANS 227."

ADD THE FOLLOWING SUBCLAUSE:

"PSLE 3.6* MATERIALS FOR SUBSURFACE DRAINS

(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 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced in two rows for 100 mm pipes and in four rows for 150 mm pipes, as shown on the Drawings.

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 Agent's 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 and Geofabrics

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."

(d) No-fines Concrete

No-fines concrete shall be as specified under Particular Specification PC.”

PSLE 5 CONSTRUCTION

Add the following subclauses:

"PSLE 5.8 CONSTRUCTION OF SUBSURFACE DRAINS

After the completion of the blinding and excavations, the bottom portion of the trench and top of blinding 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 200 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 or no-fines concrete 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 or no-fines concrete to the height above the pipes and as 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. Care shall be taken to prevent the contamination of crushed stone or no-fines concrete 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.

The drain pipes shall be joined by approved couplers. The pipes shall be laid with the perforations at the top or at the bottom, as directed. The higher end of subsurface drain pipes shall be sealed off with a loose concrete cap of class 20/19 concrete, as shown on the Drawings and at the lower end of the pipe shall be built into a manhole wall providing a positive outlet, or it shall be connected to the stormwater pipes or culverts.

Where applicable, after all the crushed stone or no-fines concrete 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.

The top 20 mm of surface of no-fines concrete under the reservoir shall receive a 1 : 4 Cement : Sand mortar and a power floated finish.

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.

PSLE 8 MEASUREMENT AND PAYMENT

PSLE 8.2 SCHEDULED ITEMS

PSLE 8.2.1 Supply and lay concrete pipe culverts

Add the following:

“Notwithstanding the stated provisions, bedding will be measured for payment in terms of the appropriate clauses of SANS 1200 LB and PSLB.”

PSLE 8.2.8 Supply and installation of manholes, catchpits and the like

Replace the contents of the item with the following:

"Separate items are listed for manholes and catchpits etc. with reference to depths (increments of 1,0 m) and type. The rate shall cover the cost of any excavation in all material (including disposal of surplus) and backfilling with suitable material in accordance with PSLE 5.8 (including importation of material if required) additional to what is measured under the relevant pipe trench item (refer to SANS 1200 DB 8.2.2 and 8.2.3).

The rate shall further cover the cost for building the manholes and catchpits complete as shown on the relevant Drawings.

The depth category of manholes and catchpits shall be measured as the difference between the cover level and the deepest invert level."

Add the following items:

“PSLE 8.2.14 Supply and lay flexible slotted HDPE drainage pipes complete with fittings and couplings on class B bedding (diameter stated)
Unit : Number

The payment provisions of 8.2.1 and PSLE 8.2.1 shall apply.

PSLE 8.2.15 Geotextile (description of type, grade, etc)... Unit: m^2

The filter fabric will be measured in place after installation.

The tendered rate shall include full compensation for procuring, supplying, cutting, overlap, jointing, placing and protecting the filter fabric as specified, as well as for wastage.

PSLE 8.2.16 Crushed stone in subsurface drains: .... Unit: m^3

The tendered rate shall include full compensation for procuring, supplying, transporting and placing the material as specified. The quantity shall be calculated from the authorised dimensions.

PSLE 8.2.17 Grade 20 MPa/19 mm concrete outlet structures for subsurface drains (including framework) Unit: m^3

The tendered rate shall include full compensation for procuring and supplying of all materials, providing and erecting formwork, reinforcing and mixing, transporting and placing concrete.

PSLE 8.2.18 Concrete caps for subsurface drain pipes Unit: number

The tendered rate shall include full compensation for supplying and installing the concrete caps.

PSLE 8.2.19 Jointing with existing network Unit: sum

The tendered sum shall include full compensation for the cost of all labour, plant, materials, excavation, backfilling, compaction and overheads to join the subsurface drains to the existing stormwater network.

PSLE 8.2.20 Breaking into existing manhole and installing new pipe:
(a) (State pipe diameter and type) Unit: sum
(b) Etc. for other diameters and types

The tendered rates shall include full compensation for the supply of all labour, plant and materials, making an opening in the existing manhole, installing the new pipe in the new opening, sealing around the pipe, breaking out the existing benching and channels where required and reconstructing them complete with rendering to

suite the new pipe arrangement, disposing of all debris to the dumping site and backfilling around the manhole with selected material.
PSLE 8.2.21 Breaking into existing stormwater pipe, installing new pipe and building new manhole:

(a) (State new pipe diameter and type) Unit: number
(b) Etc. for other new pipe diameters and types

The tendered rates shall include full compensation for the supply of all labour, plant and materials, removing a section of the existing stormwater pipe, installing the new pipe, constructing the complete, new manhole, sealing around the pipes, disposing of all debris to the dumping site and backfilling around the manhole.

PC NO-FINES CONCRETE

CONTENTS

PC 01 SCOPE

This is a Particular Specification and covers the manufacture and placing of no-fines concrete used in the Works.

PC 02 MATERIALS

Cement, aggregate and water shall comply with the requirements of SANS 1200 G.

Each size of aggregate shall be a single size aggregate graded in accordance with SANS 1083.

PC 03 CLASSES OF NO-FINES CONCRETE

No-fines concrete shall be classified by the prefix NF and the size of aggregate to be used. Class NF 19 means a no-fines concrete with a 19 mm nominal size aggregate.

The volume of aggregate per 50 kg of cement for each class of concrete shall be as follows:

Class	Aggregate per 50 kg cement
NF 38	0,33 m³
NF 19	0,30 m³
NF 13	0,27 m³

PC 04 BATCHING AND MIXING

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.

PC 05 PLACING

No-fines concrete shall be placed in accordance with the procedure approved by the Engineer. It shall be placed in its final position 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.

PC 06 PROTECTION

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:

(a) Retaining formwork in place

(b) Covering exposed surfaces with sacking or other approved material kept continuously wet

(c) Covering exposed surfaces with plastic sheeting

No-fines concrete placed during cold weather shall be adequately protected against frost for at least 3 days.

PC 07 MEASUREMENT AND PAYMENT

PC.01 Cast-in-situ no-fines concrete (state class) Unit: m^3

The provisions of subclause 8.1.3 of SANS 1200 G shall apply *mutatis mutandis*.

PART B: MECHANICAL WORKS

PS1: MECHANICAL SPECIFICATIONS

APPLICABLE STANDARDISED SPECIFICATIONS FOR MECHANICAL WORKS

STANDARD SPECIFICATION FOR MECHANICAL WORKS (INCLUDING GENERAL WORKS)

The following Standard Specifications shall generally apply to all equipment proposed on this Contract. However, there are specific requirements in certain sections of these Documents which pertain to particular items of Mechanical Equipment. These Particular Specifications shall supersede the Standard Specifications.

SERIES M1 GENERAL

M1001	General Mechanical Engineering	Applicable
M1002	Corrosion Protection	Applicable

SERIES M2 OPERATION AND MAINTENANCE AND SAFETY

M2001	Operation and Maintenance	Applicable
M2002	Maintenance Requirements (Section C5)	Applicable

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

M3001	Mountings	Applicable
M3002	Grid Floors, Guard rails and Ladders	Applicable
M3003	Waste Skip	Applicable

SERIES M4 FASTENERS

M4001	Nuts, Bolts and Fastening Sets	Applicable

SERIES M5 MEDIUM PRESSURE PIPES

M5001	Generals for Medium Pressure Pipes	Applicable

SERIES M6 PUMPS

M6001	Centrifugal Type Pumps	Applicable
M6002	Axial Flow Pumps	Not Applicable
M6004	Positive Displacement Type Pumps	Applicable
M6006	Self Priming Type Pumps RAS	Not Applicable
M60014	Air Lift Pump	Not Applicable
M60015	Submersible Type Pumps	Applicable

SERIES M7 VALVES

M7001	General Valves	Applicable
M7002	Telescopic Valves	Applicable
M7003	Actuators	Not Applicable

SERIES M9 SCREENING

M9001	Mechanically Front Raked Screen	Not Applicable
M9002	Hand Raked Screen	Applicable

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

M10001	Fluid Control Gates and Tank Valves	Applicable

SERIES M11 CONVEYORS

M11001	Hydro-Conveyor	Not Applicable
M11002	Shaftless Spiral Screw Conveyor	Not Applicable
M11003	Conveyor Belt	Not Applicable

SERIES M12 SCREW COMPACTOR

M12001	Screw Compactor	Not Applicable

SERIES M14 DISINFECTION AND CHEMICAL DOSING

M14001	Gas Chlorination	Applicable

SERIES M15 AERATION

M15004	High Speed Surface Aerator	Not Applicable

SERIES M16 SETTLING TANKS

M16002	Clarifiers	Not Applicable

SERIES M17 MIXERS

M17002	Submersible mixers	Not Applicable

SERIES M20 LIFTING EQUIPMENT

M20001	Overhead Travelling Cranes	Applicable
M20002	Crawl Beams and Chain Blocks	Applicable
M20003	Davits and Winches	Applicable

SERIES M1 GENERAL

SECTION: M10001: GENERAL MECHANICAL ENGINEERING

TABLE OF CONTENTS

SERIES M1 GENERAL

SECTION: M10001 GENERAL MECHANICAL ENGINEERING

1. SCOPE

This specification sets out the general requirements applicable to mechanical installations and shall apply where it is relevant to the Contract unless it is superseded by the project specification.

2. DESIGN SPECIFICATION

2.1. General

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.

2.2. Safety

Safety shall be an all important and overriding consideration and proper attention shall be paid to this aspect at the design stage. Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

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.

Moving parts shall be properly guarded to the satisfaction of the Engineer.

An emergency stop button shall be installed in a convenient position next to each machine. The installation shall be designed to provide immediate access without the danger of accidental operation.

Where, in the opinion of the Engineer, an installation is not safe, the Contractor shall remedy such defect at his own cost to the satisfaction of the Engineer.

2.3. Design factors

A high-quality standard is demanded and reliability, long life, 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, as applicable, be based on:

- the full range of duties which can be reasonably anticipated;
- the power and torque transmitted by the driver system under full load and stalled conditions;
- 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;
- conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers;
- a safety margin of at least 20% in addition to any service or safety factors which apply;
- twenty four hour per day operation;

- a minimum life of 100 000 hours before repair or major part replacement; and
- Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, mal-function and, as far as is practical, mal-operation; if these occurrences cannot be avoided by good design.

Machines with non-overloading characteristics shall be selected wherever possible; e.g.: motors shall be sized so that they cannot be overloaded by the driven machine.

2.4. 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 safe; i.e. must have built-in redundant elements, or be fail-to-safe; i.e. must return to a safe condition where no further damage can be done in the event of a failure, malfunction,

mal-operation, overload and, as far as practical, misuse. 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:

- be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent;
- stop or prevent from starting all equipment at risk;
- activate an alarm with a labelled indicator on the control panel whenever a protection operates;
- not permit unauthorised tampering; and
- Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

2.5. 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 and the like:

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.

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.

On abrasive applications abrasion resistant materials and slow speed operation shall be utilised.

Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. In particular, changes in section shall be radiused and care must be taken to avoid the use of welded components in areas of fluctuating stress.

The locking of nuts and pins in position shall be done to the approval of the Engineer.

Wearing parts shall be designed for interchangeability and ease of removal and replacement.

2.6. Arrangement and mounting

The arrangement and general design shall take the following requirements into consideration:

Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.

Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.

The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc.

With plant and equipment to be mounted on or against concrete or brick structures, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Drawings.

2.7. Lifting equipment

All lifting equipment shall comply with the following requirements unless otherwise stated:

All aspects of lifting equipment, including design, fabrication and installation work shall be full in accordance with the relevant aspects of the Occupational Health and Safety Act and Regulations.

Lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard.

The safe working load (SWL) shall be marked clearly on all items.

The complete installation shall be inspected and shall be tested over its complete lifting range using a load which is at least 125 % of the safe working load.

High-tensile or alloy steel chains shall have a factor of safety of at least four.

Chains shall have a factor of safety of at least five.

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.

3. MATERIALS OF CONSTRUCTION

3.1. Installation

3.1.1 General

The Works shall comply with the following:

When erected and 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.

The requirements of Sub-clause "Arrangement and Mounting" must be noted.

The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

The Contractor is not responsible for grouting puddle pipes which pass through liquid retaining walls or slabs but shall be responsible for all other grouting necessary for all plant and equipment.

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.

Corrosion protection requirements shall be carefully attended to and the relevant paragraphs of Sub-clause "Paint Application" (see Clause "Corrosion Protection: Paint Coatings) must be noted. All mating faces must be coated before and sealed after assembly.

Fastener threads must be coated with a nickel-based, anti-seize compound before assembly.

Crevices which are formed between two surfaces shall be filled, prior to final fastening, with a suitable formable packing. This applies particularly to stainless steel.

3.1.2 Alignment of shafts

Shafts for drives, such as motors, with an output above 150 kW shall be aligned to the driven shaft as follows:

Final alignment shall be done after installation and before commissioning, shall be checked in the presence of the Engineer and shall be to his approval. Alignment shall be sufficiently accurate to ensure that no initial pre-load is placed on the shaft coupling.

Each motor shall be aligned to its pump using laser aligning equipment.

The use of pourable epoxy resin chocks shall be acceptable. If pourable chocks are used, the baseplate feet do not have to be machined but each machine foot shall be provided with a screw for vertical alignment. The chock thickness shall not be less than 20 mm.

3.1.3 Materials

3.1.3.1. Materials – generally

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.

3.1.3.2. Steel

All structural steel shall comply with the requirements of SANS 1431 grade 300W and shall be legibly marked with the maker's name or trade mark and identification marks.

3.1.3.3. Plastics

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

3.1.4 Castings

Castings shall comply with the relevant South African or British Standard for the material used, including the following:

Grey Cast Iron Castings	-	SANS 1034	BS.1452
S.G. Iron Castings	-	SANS 936/7	BS.2789
Steel Castings (General Purpose)	-	SANS 1465	BS.3100
Aluminium Castings	-	SANS 989/992	BS.1490
Copper and Copper Alloy Castings	-	SANS 200	BS 1400

Particular attention shall be paid to cleanliness, soundness and neat fettling and dressing of castings. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity and 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, and sufficient space shall be provided for the use of ring or socket spanners.

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 so as to ensure that all carbides are in solution, to ensure 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, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

3.1.5 Fabrication of carbon steels

3.1.5.1. Standards

Steelwork shall be constructed, fabricated and erected in accordance with SANS 1200H where applicable.

3.1.5.2. Finish

Weld spatter and other protrusions shall be removed. Sharp edges shall be rounded to a radius of at least 2 mm.

3.1.5.3. Requirements for corrosion protection

In addition to finishing requirements, the requirements of corrosion protection application shall be taken into consideration. All surfaces must be accessible for surface preparation and coating. Inaccessible pockets, open hollow sections or the like shall not be permitted except where hot-dip galvanizing (without painting) is called for. Surfaces which cannot be properly prepared after fabrication must be abrasive blasted and coated with a two-pack epoxy pre-weld primer before fabrication.

3.1.5.4. Inspections

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop and prior to corrosion protection.

3.1.6 Fabrication of stainless steels

The requirements regarding the fabrication of carbon steels apply to the fabrication of stainless steels as well. In addition, the following requirements apply to the fabrication of stainless steels.

Surfaces which become contaminated with steel or otherwise stained or otherwise marked so as to be of uneven colour, shall be cleaned by pickling or electro-cleaning rather than by grinding.

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop.

3.1.7 Welding

General Welding Requirements

Standards**:** Standards complying with good modern practice, and acceptable to the Engineer, shall be adopted. These include the following:

BS 5135	-	Arc welding carbon and carbon manganese steelwork.
BS 4677	-	Arc welding austenitic stainless steel pipework.
BS 2633	-	Class 1 Arc welding of steel pipework.
BS 2971	-	Class II Arc welding of steel pipework.
BS 806	-	Design and construction of ferrous piping in connection with land boilers (used for arc welding specification of all pipe flanges).

Welders shall be experienced competent artisans approved in accordance with BS 4872.

Welding to be continuous: All welding shall be continuous on all sides of any joint unless otherwise approved in writing by the Engineer. No crevices will be permitted and where stitch welding has been approved by the Engineer, the crevices so left shall be sealed with an approved filling compound after priming but before further painting.

Weld appearance: Welding shall be free of blowholes 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, however, unless unavoidable.

Site welding**:** Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

Type of stainless steel: Austenitic stainless steels to be welded shall be of the low carbon grade (i.e.: 304L, 316L, etc.).

Welding rods: 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.

Welders: Only welders experienced with welding stainless materials shall be used.

General: All possible steps shall be taken to ensure maximum corrosion resistance, 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.

3.1.8 Guards

Guards shall comply in all respects with the Occupational Health and Safety Regulations and the following points shall also be noted: -

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.

Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate.

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.
Guards shall completely enclose drives and shall entirely prevent a person from touching any moving protrusion.

Allowance must be made for adjustment on belt guards or where adjustment will be required.

It shall be possible to remove the guard easily for maintenance purposes.

Guards shall preferably be fabricated of 316 stainless steel (uncoated) but may also be hot-dip galvanized, zinc-sprayed or aluminium-sprayed carbon steel, coated to specification in all these cases. Fasteners shall be M10 or larger and shall be of 316 stainless steel.

3.1.9 Machine vibration levels

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

Noise control

3.1.10.1 **Noise levels**

The noise level of the complete installation shall not exceed the following:

- a maximum noise level at the Site boundaries not exceeding an equivalent continuous sound level of 55 dB(A) when all equipment installed is being operated; and

- A maximum noise level at a distance of 1 m of each sound producing mechanical equipment of 80 dB(A).

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, etc. then an alternative solution, such as an acoustic hood or similar shall be offered.

3.1.10 Bearings

Bearing systems shall be designed to provide safe shut down without damage under normal stoppages as well as electrical supply failure.

3.1.11 Lubrication

3.1.12.1. Grease lubrication

Grease lubrication is preferred and all greasing points must be easily accessible.

Equipment with multiple greasing points shall be provided with grease lines which are piped, separately, to a single easily accessible position.

In cases in which motorised lubrication is provided to more than one destination, a distributor shall be provided. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations.

Pipework for grease distribution shall be of stainless steel or non-ferrous metal.

3.1.12.2. Oil lubrication

Oil level indicators shall be fitted for visual checking. Drain cocks, including 316 SS fittings where 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 contain an air filter.

4. MEASUREMENT AND PAYMENT

The provision of all general mechanical design, construction and material requirements as specified within this standard specification shall be included for in the overall price of equipment offered.

SERIES M1 GENERAL

SECTION M1002: GENERAL CORROSION PROTECTION

TABLE OF CONTENTS

SERIES M1 GENERAL

SECTION M1002: STANDARD SPECIFICATION FOR GENERAL CORROSION PROTECTION

1. CORROSION PROTECTION: APPLICATION AND CONTROL

1.1 Painting contractor

Surface preparation and coating application shall be carried out by 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 for approval by the Engineer.

1.2 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 or where permitted by the Engineer in writing.

1.3 Systems to be used

Systems: The corrosion protection systems to be used on the plant and equipment will usually be specified for the equipment, 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 systems: Alternative systems superior to those specified may be used if approved in writing by the Engineer.

All items to be painted: 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. Details of approved painting systems to be used are given below.

Coating appearance: After installation on Site the finished paintwork must be neat, smooth, of uniform colour and to the approval of the Engineer.

316 Stainless steel: It is not usually necessary to paint 316 stainless steel. If corrosion of 316 stainless steel does occur, and depending on the appearance or extent of the problem, the Engineer may call for pickling, electrocleaning, painting or replacement of the item at no additional cost. Painting may however be required if contaminated or stained surfaces cannot be properly cleaned or where stitch welding has been approved.

1.4 Quality control of coating application

Inspection: The Contractor shall arrange for the coating application on fabricated steelwork to be inspected throughout by the Engineer. The Engineer may approve inspections by an independent competent person (hereinafter called the Inspector) appointed by and at the cost of the Contractor.
Inspection report: 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.

Inspector qualifications: Inspectors appointed by the Contractor shall hold an appropriate qualification from either the CISA, the SAIW or the SAQCC.

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.

2. CORROSION PROTECTION: SURFACE PREPARATION

2.1 Imperfections

Welding shall be free of blowholes and all welding flux removed. All weld spatter, sharp edges and other 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, however, be performed on stainless steel). Areas to be painted shall be free of crevices. If the Engineer has permitted stitch welding, crevices shall be filled with a compatible sealing compound after the priming coat has been applied.

2.2 Abrasive blasting

Before coating all surfaces shall be properly degreased and abrasive blast cleaned to an SA3 finish with a 40-65 µm surface profile to Swedish Standard SIS 055900 of 1967. The abrasive shall comply with paragraph 4.3.3 of SANS 064 and shall be free from all traces of oil, grease, foreign matter and corrosive contaminants such as chlorides, etc. The prepared surface shall be given the first coat of the painting system within 4 hours after cleaning.

In instances where stainless steel and 3CR12 are to be painted, the surface shall be suitably abrasive blasted prior to primer application.

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.

2.4 Hot-dip galvanized surfaces

Hot-dip galvanized surfaces to be painted 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.

3. CORROSION PROTECTION: METAL COATINGS

3.1 General

Fabrication of items to be protected by metal coatings shall be in accordance with SANS ISO 14713.

3.2 Hot-dip galvanizing

Standard: Hot-dip galvanizing shall be done in accordance with SANS 121 (ISO 1461:1999) Hot-dip Galvanized Coatings on Fabricated Iron and Steel Articles.

Thickness: Coatings shall be to the thicknesses detailed in the Standard.

Passivation: 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.

White rust: Hot-dip galvanized material shall be substantially free from white rust when it is erected on site. Stacking and storing shall at all times be done in a manner to prevent white rust forming.

Repair: Damage to hot-dip galvanizing caused by welding, grinding, etc. is not acceptable. The 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. If the opinion of the Engineer is that damage is excessive, such items will be rejected by the Engineer and shall be replaced by the Contractor at his own expense.

Welding: Welding after hot-dip galvanizing is not acceptable.

Test certificate: The Contractor shall supply a galvanizer's guarantee or test certificate prior to installation.

3.3 Sprayed metal coatings

Standard: Sprayed metal coatings shall be done in accordance with SANS 1391: Standard Specification for Thermally Sprayed Metal Coatings as amended below. The statements below apply to Part 1 of SANS 1391.

Symbols: The type symbol described in Table 1 of the Standard shall be used to specify material and thickness requirements; i.e. AL for aluminium, Zn for zinc, followed by the minimum average thickness in microns.

Thickness: The minimum coating thickness for both Aluminium and Zinc shall be 150 µm.

Thickness testing procedure: The procedure laid down in Clauses 4.2.1.3 a (1) or b (1) of SANS 1391: Part 1 for the determination of the coating thickness shall not be regarded as sufficient. 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, e.g. angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes etc. 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.

Period between preparation and coating : For the purpose of Clause 3.3 of SANS 1391: Part 1, the time between preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

Sealing: Unless otherwise specified, all metal coatings shall be sealed immediately after metal-spraying using a suitable pre-treatment wash primer followed by coats of low viscosity sealant until absorption is complete. This shall be followed by a suitable top coat system to give a smooth final finish. The various coatings used shall be as specified or, if not specified, shall be selected by the Contractor to suit the duty and submitted to the Engineer for approval. The final coat shall normally be applied on site after installation. Colours shall be as specified or as agreed with the Engineer. Depending on the particular application, the following systems are acceptable:

System 1

- Application of micaceous oxide pigmented polyamide cured epoxy to achieve a dry film thickness of 60-80 µm; (Sigmarite Sealer, or equivalent);
- One coat of solvent borne modified acrylic coating to achieve a dry film thickness of 70 µm; (Sigma Topacryl coating, or equivalent); and
- One coat of solvent borne modified acrylic finish to a dry film thickness of 30-45 µm; (Sigma Topacryl finish, or equivalent).

System 2

- Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Intergard 269, Chemrite Carboline Rustbond Penetrating Sealer, or equivalent);
- Application of one intermediate coat chemical resistant vinyl copolymer to a minimum dry film thickness of 70 µm; and
- Application of one coat of vinyl copolymer chemical resistant enamel to a minimum dry film thickness of 40 µm.

System 3

- Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Chemrite Carboline Rustbond Penetrating Sealer, Intergard 269, or equivalent); and
- Application of two coats of polyurethane enamel (twin pack) to a minimum combined dry film thickness of 70 µm.

4. CORROSION PROTECTION: PAINT COATINGS

4.1 Paint selection

Paint quality: Paint shall be of best quality, of approved manufacture and brand and comply with the requirements of the relevant SANS or BS specifications.

Compatibility: To avoid incompatibility between paint coats due to variations in formulation, the different coats in any one paint system shall be provided by the same manufacturer.

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.

4.2 Paint application

Surface preparation: All surfaces shall be properly prepared as specified in Clause "Corrosion Protection: Surface Preparation".

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.

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. Mating or contact surfaces shall be prepared and primed and be brought together while the paint is still wet.

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.

Crevices: Crevices will not be permitted. Where unavoidable crevices are accepted by the Engineer, such crevices shall be filled with a compatible filler after application of the priming coat.

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.

Coating thickness: The dry film thickness shall be measured using a non-destructive thickness gauge such as the "Mikrotest" or equivalent and shall comply with the Specification.

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.

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.

Final coat: The final external coat/s shall always be applied on site after installation except for System A/1, where all coats shall be applied by a specialist applicator at his premises. A professional, smooth finish with a uniform colour is required.

4.3 Final colour code – general

The final colour code shall be as follows:

PIPEWORK				
CONTENTS OF PIPE	**BASIC COLOUR**	**COLOUR OF INDICATOR**		
		1 BAND	**2 BANDS**	**3 BANDS**
AIR				
Compressed, Power	Arctic Blue (F28)		-	-
Aeration	Arctic Blue (F28)	Canary Yellow (C61)	-	-
Instrument	Arctic Blue (F28)	Salmon Pink (A40)	-	-
Vacuum	Arctic Blue (F28)	Primrose (C67)	-	-

PIPEWORK				
CONTENTS OF PIPE	**BASIC COLOUR**	**COLOUR OF INDICATOR**		
		1 BAND	**2 BANDS**	**3 BANDS**
Lime Transfer	Arctic Blue (F28)	Crimson (A03)	-	-
Blower	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)	-	-
Lime (dry powder)	Jacaranda (F18)	Salmon Pink (A40)	-	-
Activated Carbon	Jacaranda (F18)	Light Stone (C37)	-	-
Polyelectrolyte	Jacaranda (F18)	Cloud White (G80)	-	-
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, Hypoclorite	Light Stone (C37)	Canary Yellow (C61)	-	-

WATER				
Cold Drinkable	Brilliant Green (H10)	Cornflower (F29)	-	-
Hot Drinkable	Brilliant Green (H10)	Crimson (A03)	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)	-	-
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)	-	-	-
Interchange, Stage	Drakensberg Green (H36)	-	-	-
Raw Sewage	Olive Green (H05)	-	-	-
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)	-	-
Hydraulic Power	Golden Brown (B13)	Salmon Pink (A40)	-	-

PIPEWORK				
CONTENTS OF PIPE	**BASIC COLOUR**	**COLOUR OF INDICATOR**		
		1 BAND	**2 BANDS**	**3 BANDS**
Lubricating	Golden Brown (B13)	Verdigris Green (E22)	-	-
Transformer	Golden Brown (B13)	Crimson (A03)	-	-
Paraffin	Golden Brown (B13)	Arctic Blue (F28)	-	-

PLANT AND EQUIPMENT	
EQUIPMENT	**COLOUR CODE**
FIRE FIGHTING	
Equipment and Pipework	Signal Red (A11)
ELECTRICAL	
Distribution Boards, Switch-Gear, Terminal Boxes and Conduits	Light Orange (B26)
Emergency Stop	Signal Red (A11)
MACHINE GUARDS	
Inside	Light Orange (B26)
Outside	Colour of Machine
Protruding Shafts, Exposed Gear Wheels and Rotating Parts	Light Orange (B26)
OVERHEAD TRAVELLING CRANE	
Final colour	Golden Yellow (B49)
HANDRAILS	
Horizontal Rails and Chains	Golden Yellow (B49)
Stanchions	Black
Protrusion, Sides of Ramps	Black and Yellow Diagonal Stripes
GENERAL	
Scour Pipes	Deep Buff (B24)
Valves	Basic colour of pipeline
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)
Urethane based paint is to be used for concrete surfaces Traffic paint is to be used for tarred surfaces	

EXCEPTION:

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).

4.4 Painting systems

Definition of terms

The abbreviation "d.f.t." used in this Specification shall mean dry film thickness given in microns and, except where otherwise specified, is the minimum (not average) thickness permissible.

SYSTEM A/1

Three coats of a low solvent, high solids, polyamine/amide cured, epoxy (twin pack) to a minimum thickness of 350 µm.

Notes:

The coating shall undergo holiday 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.

Applied to:

Items subject to immersion and/or wet abrasion; e.g. screw pumps, clarifier rotating arms, scum boxes and weirs, pipework, chutes, tanks, etc.

SYSTEM A/2

System A/1, plus	d.f.t = 350 µm
ash primer to SANS 723	d.f.t = 40 µm
	Total d.f.t = 390 µm

SYSTEM A/3

2 Coats of a micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (twin pack) with d.f.t = 60 µm per coat.

Total d.f.t = 120 µm

Notes:

Use Sigmarite Sealer, or equivalent.
Applied to Hot dry applications up to 200 ºC.

SYSTEM A/4

3 Coats of a micaceous iron oxide pigmented polyamine/amide cured epoxy sealer/coating (twin pack) with a d.f.t = 80 µm per coat. **Total d.f.t = 240 µm**

Notes:

Use Sigmarite Sealer, or equivalent.

Applied to Immersed applications in potable water up to 100 ºC.

SYSTEM A/5

2 or 3 coats polyamine/amide cured coaltar epoxy. **Total d.f.t. = 400 µm**

Notes:
Where paints are available in different colours, each coat shall be a different colour.

SYSTEM B/1

1 Coat aluminium filled epoxy (twin pack)	d.f.t. = 125 µm
1 Coat polyurethane enamel (twin pack)	d.f.t. = 40 µm
	Total d.f.t. = 165 µm

Application a maintenance coat over weathered coatings on steel.

Notes:

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 be in accordance with an appropriate internationally accepted standard such as the Steel Structures Painting Council of the USA or that of the Swedish Standards Institute's St standards.

SYSTEM B/2

1 Coat HB epoxy primer	d.f.t. = 100 µm
2 Coats polyurethane enamel (twin pack)	d.f.t. = 60 µm
	Total d.f.t. = 160 µm

Applied to motors, gearboxes, cast iron components, steel fabrications, etc.

SYSTEM C/1

1 Coat inorganic zinc silicate	d.f.t. = 75 µm
1 Coat high build modified acrylic coating	d.f.t. = 75 µm
1 Coat modified acrylic finish to approved colour	d.f.t. = 30 µm
	Total d.f.t. = 180 µm

Notes:

The primer must be factory applied. The intermediate and final coats may be applied on Site.

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 shall be tested for full cure before applying the subsequent coats.

This system shall not be used for items subject to immersion.

Intermediate coat shall be Sigma Topacryl, or equivalent.

Top coat shall be Sigma Topacryl Finish, or equivalent.

Applied to heavy fabricated steel items requiring a primer which travels well and/or can be left for an extended period before overcoating.

SYSTEM C/2

1 Coat inorganic zinc silicate	d.f.t. = 75 μm
1 Coat epoxy tie coat	d.f.t. = 75 μm
1 Coat polyurethane enamel (twin pack)	d.f.t. = 40 μm
	Total d.f.t. = 190 μm

Notes:

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.

Applied to:

Heavy fabricated steel items requiring a hard, high gloss colour finish - e.g. bridges, tanks, non-immersed piping, structural steel, etc.

SYSTEM C/3

1 Coat inorganic zinc silicate	d.f.t = 75 μm
1 Coat modified silicone heat resisting coating suitable for 200 ºC	d.f.t = 75 μm
	Total d.f.t = 150 μm

Notes:

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.

A tie coat suitable for 200 ºC shall be included between the primer and top coat if so recommended by the paint manufacturer.

The top coat must cure at ambient temperatures.

Applied to:

Steel and cast iron items on dry heat applications with temperatures up to 200 ºC continuous.

SYSTEM C/4

3 coats modified silicon **Total d.f.t = 120 µm**

Notes:

Steel and cast iron items on dry heat applications with temperatures up to 540 ºC continuous.

SYSTEM D

1 coat epoxy primer (twin pack, for HDG surfaces)	d.f.t = 75 µm
coat polyurethane enamel (twin pack)	d.f.t = 50 µm
	Total d.f.t. = 125 µm

Applied to:

Hot-dip galvanized steel pipes, handrails and stanchions, guards, steelwork, etc.

SYSTEM E/1

1 coat wash primer to SANS 723	d.f.t = 10 µm
1 coat zinc chromate primer to SANS 679 Type 1	d.f.t = 40 µm
1 coat universal undercoat to SANS 681	d.f.t = 35 µm
2 coats silicone urethane gloss enamel top coat to colour code.	d.f.t = 70 µm
	Total d.f.t = 155 µm

Notes:

If the specified dry film thickness of the zinc chromate primer of 40 µm is not achieved with one coat, an additional coat shall be applied.

The paints used shall be suitable for internal and external use.

An alternative priming and undercoat system of superior corrosion resistance may be used.

SYSTEM E/2

1 Coat phenolic based primer	d.f.t = 20 µm
1 Coat universal undercoat to SANS 681	d.f.t = 35 µm
2 Coats machinery enamel	d.f.t = 50 µm
	Total d.f.t = 105 µm

Notes:

The paints shall be suitable for internal and external use.

The paints selected shall not be damaged by oil spillage or grease and shall be reasonably chemical resistant.

SYSTEM E/3

1 coat zinc chromate self-etching wash primer to SANS 723 max	d.f.t = 10 µm
1 coat zinc chromate primer to SANS 679 Type 1	d.f.t = 40 µm
1 coat universal undercoat to SANS 681	d.f.t = 35 µm
2 coats single pack urethane gloss enamel	d.f.t = 60 µm
	Total d.f.t = 145 µm

Notes:

All paints shall be suitable for internal and external use.

If the specified dry film thickness of the zinc chromate primer of 40 µm is not achieved with one coat, an additional coat shall be applied.

SYSTEM E/4

1 Coat water borne vinyl based primer; Dulux Corrocote 3 or equiv.	d.f.t = 40 µm
2 Coats Acrylic Semi Gloss top coats; Ameron 234 or equivalent	d.f.t = 100 µm
	Total d.f.t = 140 µm

Applied to:

General use on hot-dip galvanized surfaces.

SYSTEM E/5

1 Coat twin pack epoxy zinc chromate primer	d.f.t = 30 µm
2 Coats acrylic semi gloss coats; Amercoat 234 or equal approved	d.f.t = 100 µm
	Total d.f.t= 130 µm

SYSTEM E/6

1 Coat epoxy strontium chromate primer	d.f.t = 25 μm
2 Coats Dulux Silthane Gloss enamel	d.f.t = 60 μm
	Total d.f.t = 85 μm

Note:

The paints used for this system must be suitable for a continuous operating temperature of 120ºC or higher.

SYSTEM F

1 Coat vinyl copolymer polyester	**Total d.f.t = 100 μm**

Applied to steel floor grating.

SYSTEM - FUSION BONDED EPOXY

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. The finished coating shall have a thickness of 300 μm and no reading shall be less than 200 μm.

Note:

The Contractor shall execute holiday detection over the full surface in accordance with SANS 1217.

The items to be coated shall be prepared in accordance with Clause 4.1.1 of the SANS 1217 and, in particular, shall have edges ground to a radius of curvature of at least 3 mm.

The surfaces to be coated shall be prepared in accordance with Clause 4.1.2 of SANS 1217 and, in particular, shall be blasted to a preparation grade of Sa 3.

Pre-heating is needed to achieve the required coating thickness.

Applied to immersed objects, cast iron valve bodies, pipe work, etc.

SYSTEM – HOT-APPLIED THERMOPLASTIC

This is a synthetic thermoplastic polyamide, Rilsan or equivalent, which shall be applied by dipping the hot object into a fluidised bed of the polymer. The coating shall be executed in accordance with the supplier's recommendations. The finished coating shall have a thickness of 300 μm and no reading shall be less than 200 μm.

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2001 OPERATION AND MAINTENANCE MANUALS

TABLE OF CONTENTS

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2001 OPERATION AND MAINTENANCE MANUALS

1. SCOPE

This specification covers the supply of Operation and Maintenance manuals as called for in the schedule of pricing. The specification sets out the general requirements applicable to the Operation and Maintenance manuals and shall apply where it is relevant to the Contract unless it is superseded by the project specification.

2. GENERAL

The contractor must submit one full set of provisional Operation and Maintenance manuals to the engineer for checking and remarks, at least one month before any commissioning and testing exercises are undertaken. The manuals will be returned to the contractor, who is to incorporate the changes and comments into the final manuals, before re-submittal.

Three sets of the final Operation and Maintenance manuals must be submitted to the engineer once the manuals have received final approval. The engineer will thereafter distribute these final manuals to Client accordingly.

3. LAYOUT OF THE MANUALS

3.1. Appearance

The manuals are to be firmly bound in plastic covered files suitable for A4 sized paper, information leaflets, suppliers' information and manuals. The Operation and Maintenance manuals are to have the following information on their covers and spines:

- Operation and maintenance manual for the specific project;
- Contractors name, address and contact details; and
- Date at which the plant was handed over to the client.

All relevant information that is not of A4 size or which is of A4 size and cannot be bound / filed into the manual is to be folded / filed into an A4 plastic sleeve which in turn is to be bound into the final manual.

Drawings on large format paper are to be neatly folded and placed in plastic sleeves so as to be removed and replaced easily.

All sections of the Operation and Maintenance manuals are to be clearly labelled and neatly partitioned.

The Operation and Maintenance manuals are to be sorted in accordance to the way the plant has been segregated into various working areas and / or stations. Repeated equipment is to be referenced or cross-referenced to the appropriate section of the manual where the relevant information for the equipment is filed.

3.2. Contents

The following details / information shall be included in the manuals:

a. Maintenance Requirements

- A summary, in tabular form, is to be provided for the major and minor services of the equipment supplied. Time intervals are to be clearly indicated.
- A summary, in tabular form, is to be provided for the standard inspection and adjustment of equipment supplied. Time intervals are to be clearly indicated.

These summaries shall specify the recommended consumables and quantitative adjustments for the equipment including contact details of the relevant suppliers. Suppliers of spares if different are to be provided along with the original equipment manufacturers details. If specialized services or maintenance is to be carried out on the equipment, the contact details of these specialists are to be provided.

b. Technical

A detailed technical description / specifications shall be provided for all equipment supplied under. This shall as a minimum include:

i. Tag number;
ii. Details of the design of the equipment including working drawings and the description of the equipment;
iii. Scope of operation including performance curves, where applicable;
iv. Electrical requirements, where applicable;
v. Materials of construction including corrosion protection specification;
vi. List of spares and where necessary additional tools.
vii. Installation details; and
viii. Condition monitoring specifications and requirements.

4. OPERATION AND MAINTENANCE

The following procedures, operational philosophies and functions of the equipment shall be provided:

1. For all equipment, the startup procedures shall be described including pre-start checks. This includes for equipment that automatically starts.
2. Shut down procedures for all equipment is to be described.
3. The operational time for each piece of equipment supplied shall be detailed.
4. The maintenance schedule, regularity of maintenance along with the time intervals between maintenance periods shall be clearly stated.
5. The checking of lubricant and coolant levels along with adjustment of machines shall be clearly described.
6. Standard inspections, services and adjustments shall be described clearly along with time intervals of when these procedures are to occur.
7. Major inspections, services and adjustments shall be described clearly along with time intervals of when these procedures are to occur.

5. MEASUREMENT AND PAYMENT

All costs sustained from the compilation of the Operation and Maintenance manuals shall be deemed to be included in the schedule of pricing, where called for in the supply of these documents.

The tendered sum shall include for the supply of a complete set of Operation and Maintenance manuals per set of equipment supplied. Final payment for these manuals will only be transferred once the engineer has approved and received the final documents along with the relevant plant drawings.

SERIES M2 OPERATION, MAINTENANCE AND SAFETY

SECTION M2002 MAINTENANCE REQUIREMENTS (SECTION C5)

C5. MECHANICAL AND MAINTENANCE (ENGINEERING) SPECIFICATIONS

H. MAINTENANCE REQUIREMENTS

H.1 Requirements

1. A 6-month Operation Service Period, which shall include only the maintenance under an Operation and Maintenance Plan for the centrifuge system, shall be included as part of the Operation Service under this Contract. The Employer shall provide all resources required for operation of the Works, while the Contractor shall be responsible for all routine and preventative maintenance.

2. The Operation Service Period of the contract will commence immediately after the Design-Build Period of the Contract.

3. The maintenance part of the contract shall be in accordance with the Schedule of Prices, and no adjustment of rates shall apply.

4. The pricing of maintenance shall be an all-inclusive monthly amount, based on a schedule of items included in this document. If no schedule of items is included in this document, the Employer's Representative shall supply one. Individual rates for the items will be added up to an all-inclusive monthly amount shown separately for each month.

5. In order to ensure compliance and efficiency, a penalty / bonus system will be applied for various activities. This will be based on a points system and when a designated number of negative points are scored during any month, a penalty will be applied and an amount will be deducted from the monthly payment. Should a designated number of positive points be scored, bonus points will be accumulated. The monetary value of accumulated bonus points will not be paid out during the contract but at the completion of the contract. Under no circiumstances shall the penalty points for a month be subtracted from accumulated bonus points.

6. The Contractor will be required to qualify for a Commissioning Certificate prior to commencement of the Operation Service Period. This is to ensure that the works are received in good working order with no defects prior to commencement of the Operation Service Period.

7. The scope of the maintenance requires the Contractor to:

    - Provide routine and preventative maintenance strictly in accordance with the relevant operating and maintenance manuals and keep in good working order all the works, plant and equipment supplied installed and commissioned under Design-Build.

    - Keep full records of routine and preventative maintenance performed on all the equipment individually, in a maintenance database, a hard copy of which must be appended to the manufacturers O & M Manuals.

- Keep all records of adjustments made to equipment.
- Take full responsibility for the maintenance of the works supplied, installed and commissioned under "Design-Build" to ensure continuous operation and functionality twenty four (24) hours per day seven (7) days a week.
- Submit monthly reports and attend all meetings which may be convened by the Engineer and /or Employer on an ad-hoc basis
- Maintenance schedules must be submitted to the Engineer and Employer for approval within 14 days of commencement of the Contract.

9. The above list may not be complete.

10. The Employer's Representative will administer the contract on behalf of the Municipality and the Engineer will act as the Employer's Representative for the duration of the Operation Service Period.

A provisional sum has been allowed for in the Schedules of Quantities to cover the costs of this service for a 6 months period. The costs will be deducted monthly from the Contractor's payment certificates, and payment will be made directly to the Engineer.

H2 Penalty System

H2.1. General

The provisions of this Clause deal with the right to reduce payment due to the Contractor as a result of his (the Contractor's) failure to comply with the provisions of the contract documentation, and/or his lack of diligence in the execution of any work, activity, duty or obligation in terms of the contract and/or his failure to or execute any instruction given by the Engineer or the Employer in terms of this contract. The stipulation of this clause shall not in any way be construed as negating or limiting any other remedy that the Employer may have in terms of the contract documentation.

For the purposes of this clause, term "reduced" or "reduction" or "deducted" when used in the context of any payment due to the Contractor means the reduction of payment due to the Contractor in terms of the payment certificate applicable to the period in which the non-compliance incident(s) occurred.

All money amounts stipulated below shall be subject to non-compliance incident(s) during the Three (3) year maintenance period.

H2.2. Non-Compliance

A non-compliance incident is any one or more of the following which arises or occurs as a result of the Contractor′s (or any of his site employees) action or lack of action or non-compliance with the provisions of the contract documentation:

H.2.2.1 Endangerment to the safety of the Employer's or user's personnel and vehicles, the Contractor's site employees and the public. (penalty points = 6)

H.2.2.2 Failure to implement any instruction given by the Engineer within the period prescribed by such instruction or the contract documentation (as applicable). (penalty points = 4)

H.2.2.3 Unauthorised removal from the site of any plant and equipment and record originals. (Penalty points = 4)

H.2.2.4 Inaccurate and/or record keeping or failure to submit monthly records. (Penalty points = 3)

H.2.2.5 Failure to advise the Engineer and/or employer of any impending equipment breakdowns identified during routine maintenance work. (Penalty points = 3)

H2.2.6 The non-compliances stated in H2.2.1 to H2.2.5 above will attract the penalty points indicated in brackets.

H.2.2.6 The following table indicates the penalty point allocation which will be applied to any callout made by the Employer or the Engineer. An emergency call out requires urgent attention and the Contractor will be informed whether a call out is an emergency or not.

Reaction Time	**Penalty points**			
Hours	**Normal**	**Emergency**	**TOTALS**	
2h or less	0	0		
4 hr to 5h 59min	0	3		
6hrs to 7h 59 min	1.5	6		
8hrs to 9h 59min	3	9		
10hrs to 11h 59min	4.5	12		
12hrs to 13h 59min	6	15		
14hrs to 15h 59min	7.5	18		
16hrs to 17h 59min	9	20		
18hrs to 19h 59min	10	23		
20hrs to 20h 59min	11.5	26		
22hrs to 23h 59min	13	30		
Greater than 24hrs	15	40		

NOTE : Each point is worth R500

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3001: MACHINE MOUNTINGS

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3001: MACHINE MOUNTINGS

1. SCOPE

This specification covers the requirements for machine mountings which are to be included with all equipment offered and not as separate items.

2. DESIGN SPECIFICATIONS

2.1 Common baseplates

Both direct-coupled and belt-driven machines shall be mounted with their drivers on common cast iron or fabricated steel baseplates of rigid construction.

2.2 Corrosion protection

Steel baseplates shall be hot-dip galvanized unless specified otherwise.

2.3 Machined mounting pads

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 solid 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.

2.4 Fasteners

Anchor fasteners shall be of grade 316 stainless steel with threads coated with a nickel-based, anti-seize compound before assembly.

2.5 Alignment

Preliminary alignment 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 approval of the Engineer and a final alignment check witnessed by the Engineer must be carried out by the Contractor prior to start up.

2.6 Shimming

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.

2.7 Jacking screws

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 and side way 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 stainless steel.

2.8 Grouting

Baseplates shall be designed and grouted as 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. The initial grouting shall be overseen by the supplier's technical representative.

2.9 Soleplates

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.

3. MEASUREMENT AND PAYMENT

All mountings are to be included in the price for the item of equipment offered. Mountings are to be included as ancillary equipment where reference is made to “ancillary equipment”

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3002: GRID FLOORS, GUARD RAILS AND LADDERS

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3002: GRID FLOORS, GUARD RAILS AND LADDERS

1. SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of all grid floors, guard rails and ladders.

2. DESIGN SPECIFICATION

2.1 Grid flooring

All grid flooring shall be GRP type or equal approved with bearer bars across the shorter span. The depth of bearer bars shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm. Panels are to be set level and fixed down in angle frames so as to prevent rocking. All cut-outs in grid flooring for pipes, valve spindles and the like are to be banded and made before any corrosion protection is done. The edges of removable grid access covers must also be banded.

2.2 Guard railing

Guard railing shall be provided in accordance with legislated requirements and shall be provided generally in positions where the vertical change in level is 1 000 mm or greater.

Guard railing shall comply with SANS 0104.

All guard railing shall be of GRP and shall comprise hand and knee rails not less than 32 mm diameter and stanchions spaced at not more than 1,8 m except where specifically directed otherwise in writing by the Engineer.

On platforms, walkways, landings or around dangerous areas the vertical height, measured from the top of the hand rail to the floor or surface, shall be at least 1 000 mm.

On stairways and fixed ladders the rails shall be parallel to the stringers, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

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. Contractors shall provide proof that their guard railing has been tested and withstands these loads. The loads specified in SANS 10160 for guard railing and stanchions are to be adhered to.

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.

Railing, if tubular, shall be joined using the slip-jointing method with separate and neatly fitting tubular inserts fitted into the railing bore. If used, pins shall have their ends peened over and smoothed or, if taper pins are used, shall be filed off flush with the rail. The joint shall withstand the loads specified above when situated in any position including centrally between two stanchions. Joints shall preferably be located inside the stanchion balls. All joints shall be sealed.

Railings shall be ended off with positively fixed (pinned) 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.

Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction. Welding shall be compatible with the material, shall not impair the strength or corrosion resistance of the material, shall be continuous and shall be smoothly finished and then passivated.

Stanchions shall be self-draining to suit the mounting arrangement.

Holes for the rails to go through the stanchions shall have a diametral clearance not exceeding 1 mm but preferably 0,5 mm. On stairways with stanchions vertically mounted, the hole shall be angled to suit and shall accurately fit the angled rail with the abovementioned clearances. The crevices caused by rails passing through the stanchions shall be sealed.

Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm. Two fasteners, of minimum size M16, shall be used to attach the foot. Foot material thickness shall be not less than 8 mm. Neatly fitting packing shall be fitted under stanchion feet to prevent the formation of crevices.

Stanchion feet which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 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 attach the foot to the concrete. Foot material thickness shall be not less than 10 mm. Non-shrink, cementitious grout shall be applied under the foot just prior to final tightening of nuts.

2.2.1 Guard railing in public places

The requirements for guard railing at equipment installations shall also apply for guard railing for public places. The following specific requirements must also be complied with:

The structural design shall be done in accordance with the requirements of SANS 0104.

No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

2.3 Permanent ladders and stairs

2.3.1 General

Permanent ladders shall comply, primarily, with the requirements of the OSH Act and, secondarily, with SANS 10400.

2.3.2 Permanent ladders

Ladders shall comply with the following detail design aspects:

Access points to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

No part of the ladders shall project into the passageway.

The clear width between stringers shall be between 450 mm and 550 mm.

A minimum clear space of 230 mm must be allowed behind the rungs.

The diameter of the rungs shall be between 20 mm and 50 mm.

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.

Stringers shall be formed from flat bar. The vertical distance between the ladder support brackets shall not exceed 1 800 mm.

The stringers shall extend to 1 100 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 stringers shall be supported by vertical structural sections (not flat bar) whose footings shall comply with this Specification for guard rail stanchion feet.

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.

Except on chimneys, the height of a ladder should not exceed 6 000 mm. Greater heights shall be provided with intermediate landings between each 6 000 mm ladder section.

If the height between start and end levels is over 4 000 mm, the ladder shall be fitted with a safety cage. The safety cage shall extend at least 1 000 mm above the higher landing. The cage shall be no more than 700 mm away from the plane of the rungs. The cage shall comprise no fewer than seven vertical elements.

Anchor bolts shall be of grade 316 stainless steel and shall be no smaller than M16.

Stringers, rungs and anchor brackets 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.

2.3.3 Stairs

Stairs shall comply with BS 5395

3.

4. MATERIALS OF CONSTRUCTION

3.1 Grid flooring

Grid flooring and frames shall be GRP Materials. Painting shall be done to suit the relevant safety codes.

Where grid flooring bears onto painted surfaces, strips of rubber insertion material shall be secured under the grid flooring to protect the paint.

The fixing clip set (saddle clamp and locking plate) and all fasteners shall be of grade 316 stainless steel.

3.2 Guard railing

All guard railing shall be of GRP materials

Stanchion feet shall be epoxy-coated.

A nickel-based, anti-seize compound shall be applied to all threads before fastening.

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.

Inserts for internal slip joints may be of non-corrosive material using steel reinforcing provided the steel is completely enclosed.

Where kickplates are required by legislation, these shall extend to 150 mm above the walkway level.

3.3 Permanent ladders and stairs

Unless other materials are specified, ladders and stairs shall be of carbon steel and hot-dip galvanized after all fabrication has been completed.

5. TESTING AND COMMISSIONING

4.1 Works testing

Where applicable an inspection of the assembled units will be conducted at the manufacturer’s premises to check material integrity, corrosion protection and fabrication soundness. Material certificates are to be issued to the engineer before deliver to site of the equipment.

4.2 Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

1. An inspection will be carried out to ascertain that the equipment has been installed correctly and with due diligence.

2. Any load testing required.

The equipment will be considered acceptable when:

1. Equipment has been correctly installed and satisfies the engineer.

2. The equipment passes any load tests called for.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

6. MEASUREMENT AND PAYMENT

5.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

5.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3003: WASTE SKIP

TABLE OF CONTENTS

SERIES M3 AUXILIARY MECHANICAL EQUIPMENT

SECTION M3003: WASTE SKIP

1. SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of a waste skip.

2. DESIGN SPECIFICATIONS

2.1 General

The waste skip is to have a capacity of 3 cubic meters and must have provision in its design to be able handled and transported by a skip loader vehicle.

3. MATERIALS OF CONSTRUCTION

3.1 Waste Skip

The waste skip is to be fabricated from mild steel plate. The floor is to be 4 mm thick and the sides are to be 3 mm thick. Suitable sized lifting lugs are to be provided, two on each side of the waste skip from which a skip loader vehicle would be able to safely and securely lift the unit under full load. The waste skip is to be reinforced on all corners and on its side. Drainage holes are to be provided for the release of any fluids that may accumulate in the item. Two channel iron frames is to be welded to the underside of the unit so that the base of the container underside clears the ground or bogey on which it is mounted.

3.2 Corrosion protection

Corrosion protection shall be carried out in accordance with the requirements of the General Corrosion Protection Specification: -

Mild Steel : System – Fusion Bonded Epoxy 250 microns minimum.

Colour : Golden Yellow (B49)

4. TESTING AND COMMISSIONING

4.1 Works testing

The waste skip is to be able to be loaded and off loaded by a skip loader vehicle and be transported safely and securely under full load conditions.
Checks on all equipment will be conducted for correct operation and functioning during the defects liability period at 1 month, 6 months and 12 months after final plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be accordance with the original equipment manufacturers recommendations

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M4 FASTENERS

SECTION M4001: NUTS, BOLTS, AND FASTENING SETS

TABLE OF CONTENTS

SERIES M4 FASTENERS

SECTION M4001: NUTS, BOLTS, AND FASTENING SETS

1. SCOPE

This specification covers the requirements for fasteners and fastening sets which are to be included with all equipment offered and not as separate items.

2. DESIGN SPECIFICATIONS

2.1 Fasteners general

2.1.1 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.

2.1.2 Fasteners M12 and smaller

All fasteners M12 and smaller shall be manufactured of grade 316 stainless steel.

2.1.3 Fasteners larger than M12 - in corrosive areas

All fasteners in corrosive areas shall be manufactured of 316 SS. 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.

2.1.4 Fasteners larger than M12 - Non-corrosive areas

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

2.1.5 High tensile bolts

Where high tensile bolts are required by the design, they shall be hot-dip galvanized and painted. The bolt holes and crevices shall be filled and sealed prior to painting.

2.1.1 Material compatibility

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. 316 stainless steel bolts must be used to fasten together 316 stainless steel fabrications or flanges.

2.1.6 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.

2.1.7 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 thread shall be treated in the area under the final position of the nut. Compound on the exposed thread shall be cleaned off after installation. If it is found during inspection that compound has not been applied, the Contractor shall disassemble all fasteners and comply with this requirement.

2.1.8 Thread projection

Bolt threads shall project between 1 and 6 mm from the head of the nuts when fixed. Longer projections will only be allowed if the Contractor can show that bolts of a more suitable length are not manufactured.

2.1.9 Corrosion protection

After installation the exposed surfaces of bolts not made of 316 stainless steel shall be coated as for 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.

2.2 Anchor fasteners

2.2.1 Type and material

All anchor fasteners shall be of grade 316 stainless steel.

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.

2.2.2 Hook bolts

Grade 316 stainless steel 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.

2.2.3 Alternative anchor bolts

The use of 316 stainless steel "Hilti Kwik Bolt" stud bolts or similar 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.

2.2.4 Through-bolt anchors

Where machinery is anchored by studs or bolts which extend through the supporting structure and is therefore fastened down with the use of nuts from both sides, these, together with associated washers and brackets, shall also be of grade 316 stainless steel.

2.2.5 Anti-seize compound

All threads shall be coated with an approved nickel-based, anti-seize/corrosion protection compound before assembly.

3 MEASUREMENT AND PAYMENT

All fasteners and fastening sets are to be included in the price for the item of equipment offered. The unit item offered will include the price of the fastener and fastening sets. Fasteners are to be included as ancillary equipment where reference is made to “ancillary equipment.”

SERIES M5 MEDIUM PRESSURE PIPES

SECTION M5001: MEDIUM PRESSURE PIPES

TABLE OF CONTENTS

SERIES M5 MEDIUM PRESSURE PIPES

SECTION M5001: GENERAL MEDIUM PRESSURE PIPES

1. SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of medium pressure pipes.

2. DESIGN SPECIFICATIONS

2.1 General

2.1.1 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.

2.1.1 Steel pipework

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 11 Standard Specification for Steel Pipe, Fittings and Specials.

2.1.2 Stainless steel

Stainless steel pipework shall be to ASTM 312. Schedule 10 pipes and fittings shall be used except where otherwise specified.

2.1.3 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.

2.1.4 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.

2.1.5 Butt weld 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.

2.1.6 Malleable cast iron

Malleable cast iron fittings shall be to SANS 14 (SANS ISO 49).

2.1.7 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's Clause 6 regarding freedom from defects and casting appearance and Clauses 8, 9 and 10 regarding casting accuracy will be strictly applied. 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.

2.1.8 Copper pipes

Copper pipes shall be to BS 2871 or approved equal.

2.1.9 Plastic pipework

Polyethylene or Polypropylene pipes shall comply with SANS 533 and SANS 1315 respectively and shall carry the SANS mark. The contractor manufacturing and installing the pipework shall satisfy the requirements of SANS ISO 9002. PVC pipework is not acceptable except where specified.

An operating life of 50 years shall be designed for and appropriate derating factors shall be applied to suit the application. The rated maximum working pressure at operating conditions of the class of pipe selected shall be not less than 1,5 times the actual maximum operating pressure. 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.

Note that nominal bores and pipe diameters specified must be regarded as the minimum inside diameter.

2.2 Pipework design

2.2.1 Pipe type and material

The type and material of pipe to be used will be given in the Detailed Specification.

2.2.2 Pipe diameters

Unless otherwise specified in the Detailed 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
	ALLOWANCE FLOW VELOCITY [m/s]			
LIQUID GRIT FREE:	0.75 max	1,25 max	1,5 max	2 max 1 min
HIGH SOLIDS OR GRIT:		0,8 min 1,5 max	1 min 1,75 max	2 max 25 max
STEAM	10 max	15 max	20 max	
AIR AND GAS above 10 kPa below 10 kPa	5 max 2,5 max	8 max 3 max	10 max 4 max	12 max 5 max

*Grit free liquids include potable water, final effluent, centrate, supernatant, etc. Liquids considered to have high solids content will include raw sewage, sludge and grit slurry.

If anomalies occur within the same system using the above table, the larger pipe diameter shall generally be used.

2.2.3 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 not reducing bushes shall be used where required.

All steel pipes larger than DN 50 shall be flanged or fitted with pipe couplings as applicable.

Suitable flexible couplings shall be incorporated wherever necessary to facilitate maintenance or isolate vibration. A flexible pipe coupling shall be provided on each pump suction. Flexible couplings shall be adequately restrained by harnesses as specified in the Clause "Flexible Pipe Couplings".

2.2.4 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.

2.2.5 Condensate drains

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.

2.2.6 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.

2.2.7 Encased pipes

Pipework to be permanently encased in concrete, cement or similar shall be of cast iron or 316 stainless steel for steel and stainless steel pipework respectively. The encased portion must be a separate section flanged both ends with adequate clearance between the wall surface and the flanges. 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.

2.2.8 Isolation

The layout design shall make provision for isolation and easy removal of mechanical equipment.

2.2.9 Nozzles for fittings, gauges, etc.

Nozzles on pipework (for installation of gauges, transmitters, drain pipes, cooling water take-offs, air 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 in diameter, painted 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.

A nozzle on cement-lined, carbon steel pipe work shall consist of a flanged, cement lined tee-off (of at least 100 mm diameter) and a non-corrosive blank flange.

Internally painted, small diameter carbon steel nozzles and screwed carbon steel tee-offs are both unacceptable as nozzles. Carbon steel pipe work may be provided with small diameter, grade 316 stainless steel nozzles which are welded into the pipe work if the Engineer considers this acceptable in the application.

3. MATERIALS OF CONSTRUCTION

3.1 Pipework installation

3.1.2 Appearance

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.

3.1.2 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.

3.1.3 Supports

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.

A drawing or sample of proposed pipe supports shall be submitted to the Engineer for approval prior to manufacture.

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.

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.

Where the Engineer approves the use of concrete pipe supports to be built by a civil contractor under a separate contract, these shall 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.

3.1.4 Pressure testing

All pipelines shall be pressure tested to 1,5 times maximum working pressure. This shall be done before covering up the pipeline in any way where applicable and shall be witnessed by the Engineer.

3.2 Flanges

3.1.1 Standards

All standard flanges shall comply with SANS 1123. For flange sizes not included in the SANS standard, 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. Drilling and installation of flanges shall be "off-centre".

3.1.2 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.

3.1.3 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.

3.1.4 Butt flanges

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 hot rolled stainless steel angle section. The hot-dip galvanized butt flange must be electrically insulated from the stainless steel pipework.

3.1.5 Rectangular flanges

The use of square or rectangular flanges shall be avoided and will not be accepted for pressures above 100 kPa. The thickness of flanges designed for positive or negative pressures between 20 and 100 kPa shall be not less than 75 % that of a circular flange of equivalent nominal opening area manufactured to Table 600 of SANS 1123. For pressures 20 kPa and below the flange thickness shall be to the Engineer's approval. Bolting shall in all cases be to the Engineer's approval.

3.1.6 Gaskets

The jointing material used on flange joints shall be of the replacement material for compressed asbestos fibre at least 3 mm thick complying respectively with BS 2494 or BS 1832, as applicable. No compressed asbestos fibre gaskets will be accepted. 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.

3.3 Flexible pipe couplings

3.3.1 Coupling types

Where movement or misalignment must be allowed for, or if necessary for any other reason, rubber expansion joints may be used if approved by the Engineer. The flexible material used for rubber expansion joints shall be chosen specifically for maximum resistance to bursting.

Flexible couplings and flange adaptors may also be used if approved by the Engineer and these shall be supplied without centre register unless otherwise specified.

Flexible couplings for cast iron pipes and, where specified, for asbestos cement pipes, shall be of the cast iron short or long collar type. Flexible couplings for steel or stainless steel pipework may be of the "Victaulic" type or approved equal for grooved or shouldered end pipes.

Couplings for plastic pipes shall be of the clamp type employing buttressed pipe ends.

3.3.2 Pipe ends

Pipe ends shall be prepared strictly 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.

3.3.3 Supports and anchors

Pipework using flexible couplings shall be supported and anchored strictly in accordance with the coupling manufacturer's recommendations. Harnesses against separating forces shall be provided where appropriate to the approval of the Engineer. Where this restraint is not provided by the layout, other neat and positive means of harnessing shall be provided. A system incorporating additional flanges or lugs cast on in the case of cast iron, or welded on for steel, and connected by tie bars or positively fixed to anchors, will be accepted. Systems relying purely on friction will not be acceptable.

3.3.4 Corrosion protection

Cast iron couplings shall be painted. Steel couplings for gas applications shall be hot-dip galvanized. Steel couplings for fluid applications shall be coated in accordance with System – Hot Applied Thermoplastic or System - Fusion Bonded Epoxy.

Metal backing flanges for rubber expansion joints shall be of stainless steel or hot-dip galvanized steel.

3.3.5 Fasteners

Fasteners for Viking-Johnson type couplings shall be of grade 316 stainless steel. This includes coupling studs, stub studs (i.e. studs welded to the flanges of flange adaptors), washers and nuts.

Fasteners for other couplings shall be of stainless steel or hot-dip galvanized steel.

3.3.6 Underground protection

When couplings are part of a buried pipeline the couplings shall be enclosed with "Denso mastic" to a smooth finish, wrapped with "Denso tape" and then wrapped with a polythene sheet which is strapped in place. If the operating temperature is likely to exceed 70ºC the Denso paste and tape shall be replaced with a suitable grease or a suitable sealer.

4. TESTING AND COMMISSIONING

4.1 Works testing

4.1.1 Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

1. Visual inspection of the pipes to ascertain corrosion protection integrity.

2. Where applicable, deemed necessary or called for by the engineer, a dry film thickness test will be conducted.

The equipment will be considered acceptable when:

1. The minimum requirements of the standard specification for General Corrosion Protection has been met.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5 SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M6 PUMPS

SECTION M6001 : CENTRIFUGAL TYPE PUMPS

TABLE OF CONTENTS

SERIES M6 PUMPS

SECTION M6001 : CENTRIFUGAL TYPE PUMPS

1. SCOPE

This specification covers the design, supply, delivery, transport, handling, storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for centrifugal type pumps.

2. DESIGN SPECIFICATION

2.1 Description

All centrifugal pumpsets shall be designed and supplied in accordance with ISO 9908 – Technical specification for centrifugal pumps - Class III. The Manufacturer / Supplier shall review the rated (guarantee) duties and offer his best technical and financial solution at the highest operational efficiency for each station, based on the type (i.e. end-suction, multistage or horizontal split casing), size and arrangement of pumpsets proposed.

Although all pumps shall be installed within an enclosed installation they must be designed and supplied such that they are able to operate under normal Southern African outdoor environmental conditions. The Supplier/Manufacturer shall specify and offer the recommended shaft sealing arrangement, either gland packing or mechanical seal as they deem to be suitable under the operating conditions specified.

All pumpset flanges shall as a minimum be pressure rated and drilled in accordance with SANS 1123 Table 1600/3. Should the casing design pressure exceed this pressure rating then the flange drilling requirements shall be upgraded accordingly.

The prime mover for all pumpsets shall be an electrical induction motor driven via a suitably rated flexible coupling. The operating speed of all pumps should preferably be less that 1500 rpm but must not exceed 3000 rpm.

Tenders will be assessed on the best technical and financial value offered. In adjudicating the tenders, in addition to price, account will be taken of:

- Rated (guarantee) operating efficiency offered to be specified in the data sheets to be submitted with this tender;
- Equipment offered;
- Delivery period;
- Ease of operation and maintenance;
- Technical resources and previous project experience;
- General soundness and robustness of design;
- Reliability of components;
- Availability of spares and after sales service; and
- Any special conditions or qualifications put forward by the Tenderer.

The following National and International Specifications shall be applicable:

ISO 9905:1994	Technical specifications for centrifugal pumps – Class I
ISO 5199:2002	Technical specifications for centrifugal pumps – Class II
ISO 9908:1993	Technical specifications for centrifugal pumps – Class III
ISO 76:1987	Rolling bearings – Static load ratings
ISO 281:1990	Rolling bearings – Dynamic load ratings and rating life
ISO 2372:1974	Mechanical vibration of machines with operating speeds from 10 to 200 rev/s – Basis for specifying evaluation standards
ISO 3069:1974	End suction centrifugal pumps – Dimensions of cavities for mechanical seals and for soft packing
SANS 1123:2000	Pipe Flanges
ISO 7005-1:1992	Metallic flanges – Part 1: Steel flanges
ISO 7005-2:1988	Metallic flanges – Part 2: Cast Iron
ISO 7005-3:1988	Metallic flanges – Part 1: Copper alloy and composite flanges
ISO 1940-1:2003	Mechanical vibration -- Balance quality requirements for rotors in a constant (rigid) state -- Part 1: Specification and verification of balance tolerances
ISO 9906	Rotordynamic pumps – Hydraulic performance acceptance tests – Grades 1 and 2 *(ISO 9906 replaces ISO 3555 and ISO 2548)
*ISO 3555:1977	Centrifugal, mixed flow and axial flow pumps – Code for acceptance tests – Class B
*ISO 2548:1973	Centrifugal, mixed flow and axial flow pumps – Code for acceptance tests – Class C

3. MATERIALS OF CONSTRUCTION

3.1 Materials

Materials						
Medium	**Raw Water (option 1)**	**Raw Water (option 2)**	**Potable Water (option 1)**	**Potable Water (option 2)**	**Sea Water (option 1)**	**Sea Water (option 2)**
Volute casing	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Casing wear ring	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Impeller	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Impeller wear rings	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Pump shaft	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA
Shaft protecting sleeve	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA

3.2 Corrosion protection

Corrosion protection is to be advised. Contractor is to selects most appropriate corrosion protection technology when determining cost.

4. TESTING AND COMMISSIONING

4.1 Factory acceptance tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.

Each pump shall be subject to a hydraulic performance and NPSH test in accordance with ISO 9906, Class I or II, at an approved test facility. The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.

Where pumps are supplied as complete pumpsets, these shall preferably be tested as such and shall be complete with own job motors.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.
Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

4.2 Site acceptance tests

Each pumpset shall be subject to a mechanical commissioning run to ensure that it is operating in accordance with its intended design duty and that there is no undue noise, vibration or excessive heating of the units.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, in complete working order.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

VARIATIONS AND OR ADDITIONS TO ISO 9908: FIRST EDITION 1993-11-01: TECHNICAL SPECIFICATIONS FOR CENTRIFUGAL PUMPS – CLASS III

3. Definitions

3.1 Rated conditions

Add to the Sub-Clause :

The rated (guarantee) conditions for all pumpsets pertaining to this tender are itemised and described in the Project Specification: Portion 1. These are furthermore outlined in the datasheets to be completed per pumpset to be submitted with this tender.

The pump selected shall be sized such that the rated (guarantee) duty is positioned as close as possible to the Best Efficiency Point (BEP) of the pumps hydraulic and shall be capable of at least 125% of the rated duty flow. The rated (guarantee) duty flow must be pitched no less than 60% and no greater that 110 % of the BEP flow.

4. Design

4.1 General

4.1.1 Characteristic Curve

Add to the Sub-Clause:

The pumps are to be selected so as to have stable, non-overloading characteristic curves.

Pump characteristic curves shall show head, efficiency, power demand and NPSH required, plotted against discharge flow rate in metric units at the rated impeller diameter and speed required to satisfy the rated (guarantee) duty.

Measurement	Preferred Unit	Symbol
Differential head	Meters	(m)
Discharge flow	Litres per second	(l/s)
Efficiency	Percent	(%)
Power absorbed	Kilowatt	(kW)
NPSHr	Meters	(m)
Impeller diameter	Millimeters	(mm)
Speed	Revolutions per minute	(rpm)

The performance curves shall indicate pump performance characteristics at maximum, minimum and rated impeller diameters.

Where two or more pumps are required to operate in parallel, care shall be taken to ensure that one pump can operate in isolation on the system without risk of damage to the pump itself or system within which it operates. This operating point shall be referred to as the “runout duty point’. Details of the hydraulic performances expected under these conditions shall be verified by superimposing the rated characteristics curve of the pumps offered onto the system curve (where) provided. This graphical data as well the runout hydraulic conditions to be specified on the data sheets provided, shall be submitted with this tender.

4.1.2 Net positive suction head (NPSH)

Delete the Sub-Clause and substitute:

The NPSHR shall be based on coldwater as specified in ISO 2548 and ISO 3555. The NPSHA must exceed NPSHR by a margin of at least 30% or 0.5 m, whichever is the greatest, at the rated (guarantee) point specified. The basis for use in performance curves is that NPSH corresponding to a drop of 3% of the total head of the first stage of the pump (NPSH3).

Where a pump may be subjected to operating under a runout duty point condition, the NPSHA must exceed NPSHR by a margin of at least 15% under this scenario.

4.2 Prime movers

4.2.1 Defined operating conditions

Delete the Sub-Clause and substitute:

The prime movers power output rating shall equal or exceed at least the following margins according to the pump's absorbed power demand at the rated (guarantee) point.

Margin	Description	Value
50%	For pumps requiring up to	2 kW
40%	For pumps requiring from	2 to 5 kW
30%	For pumps requiring from	5 to 10 kW
20%	For pumps requiring from	10 to 30 kW
15%	For pumps requiring from	30 to 100 kW
10%	For pumps requiring	Over 100 kW

Where a unit may be subjected to operating at a run-out duty point condition, the power output rating of the prime mover shall be at least 5% greater than the power absorbed by the pump at this point.

4.3 Critical speed, balance and vibration

4.3.2 Balance and vibration

Add to the Sub-Clause:

Rotating elements shall be statically and dynamically balanced according to ISO 1940-1:2003 to a balance quality grade of G2.5. Balancing certificates shall be submitted where specified, in an approved format.

A flat surface measuring at least 25 mm in diameter must be provided at both DE and NDE bearing housings in the horizontal and vertical planes such that a probe from a portable vibrometer may be positioned so as to measure resultant vibration amplitudes.

Failure to achieve the vibration limits specified may render the equipment liable for rejection. The Contractor shall be responsible to rectify the equipment to achieve the specified limits at his own expense.

4.4.4 Mechanical features

4.4.4.1 Dismantling

Add to the Sub-Clause:

The manufacturer/supplier must include for and indicate in their offer any special tools required for operation and or maintenance of the pumping units.

4.6 Forces and moments

Delete the Sub-Clause and substitute:

The manufacturer/supplier shall provide details of allowable external forces and moments on branches in the data sheets to be submitted with this tender.

4.7 Branch (nozzle) flanges

Delete the Sub-Clause and substitute:

Flanges shall be designed and drilled in accordance with SANS 1123. The rated pressure of the flanges shall be as stated in the data sheets

4.8 Impellers

4.8.1 Impeller design

Add to the Sub-Clause:

The rated impeller diameter shall not exceed 95% of full diameter. Similarly the rated impeller diameter shall not be less than 105% of the minimum diameter.

Pumps that are required to handle raw sewage or similar medium shall be capable of passing solids corresponding to an 80 mm diameter sphere as well as rags, paper and other stringy material without clogging.

4.12 Shaft Sealing

4.12.1 General

Add to the Sub-Clause:

The preference for either packed glands or mechanical seals shall be specified in the data sheets. If no preference is stated the supplier shall provide his standard design arrangement or alternatively advise otherwise.

4.13 Nameplate

Delete the Sub-Clause and substitute:

Nameplates shall be securely attached to the pump.

The minimum information required on the nameplate shall be name (or trademark) and address of the manufacturer or supplier, identification number of the pump (for example, serial number or product number), model type and size, rated (guarantee) flow, rated (guarantee) head, rated speed and actual impeller diameter.

4.16 Baseplates for horizontal pumps

4.16.1 General

Add to the Sub-Clause:

Baseplates are to be rigidly designed such that the combined unit (uncoupled pump, motor and baseplate) may be transported as a single item without any excess deflections or strains applied to any of these items. Suitable lifting lugs shall be provided on the baseplate design for transportation and lifting purposes. Lifting of the combined unit must not be carried out by slinging from the pump or motor.

Baseplates shall be supplied complete with holding-down bolts and sufficient steel packers to allow shimming for alignment and grouting. All shims are to be neatly cut so as not to protrude beyond the baseplate or motor‘s base/feet.

acking bolts shall be included in the baseplate design to aid in the alignment of rotating equipment.

4.16.2 Assembly of pump and driver on baseplate

Add to the Sub-Clause:

Pre-alignment of the pump and motor shall be carried out before transporting the combined unit to site. The alignment of these items shall be checked again after final installation and before the coupling and commissioning of the pump and motor sets are undertaken.

6. Shop inspection and tests

Delete the Sub-Clause and substitute:

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.
Each pump shall be subject to a hydraulic performance and NPSH test in accordance with ISO 9906, Class I or II, at an approved test facility. The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.

Where pumps are supplied as complete pumpsets, these shall preferably be tested as such and shall be complete with own job motors.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation to Clause 4.1.1 above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.

Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

7. Preparation for dispatch

7.2 Securing of rotating parts for transport

Add to the Sub-Clause:

The combined pump and motor set shall be transported uncoupled.

Annex A: Centrifugal pump – Data sheet

Add to the Sub-Clause:

The Centrifugal pump – Data sheets to be completed and submitted with this tender are presented with the Returnable Schedules.

Annex B: Enquiry, proposal and purchase order

B.1.1 Proposal

Add to the Sub-Clause:

The proposal shall include at least the following technical information:

- List of all deviations to the pump specifications;
- centrifugal pump data sheet completed in full;
- preliminary outline drawing with installation information;
- typical cross-section drawing or exploded view;
- pump characteristic curve;
- Superimposition of pump and system characteristic curves;
- List of special dismantling considerations and or tools required for operation and maintenance procedures.

A full list of documents (to be submitted both with the proposal as well as after contract award) is presented in the list of Returnable Documents.

SERIES M6 PUMPS

SECTION M6015: SUBMERSIBLE TYPE PUMPS

1. SCOPE

This specification covers the design, supply, delivery, transport, handling, storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for Submersible type pumps.

2. DESIGN SPECIFICATION

2.1 Description

All submersible pumps shall be designed and supplied in accordance with ISO 9001– Technical specification for submersible pumps. The Manufacturer / Supplier shall review the rated (guarantee) duties and offer his best technical and financial solution at the highest operational efficiency based on the type for pumping raw effluent.

The pump shall be water pressure –tight encapsulated flood proof motors in standard version with option of jacket for cooling system. The pump shall be suitable for dry and wet installations. The pump shall be fitted with a Vortex impellor with case hardened edges. The pump shall be manufactured in such a way that will enable the adjustment of the bowl towards the impellor to maintain maximum efficiency at all times.

The flow and pressure requirements must be calculated in accordance with the Technical Data Sheets. Where the Technical Data Sheets refer to a Contractor design, the flow and pressure is to be provided.

The operating speed of all pumps should preferably be less that 1500 rpm but must not exceed 3000 rpm.

Tenders will be assessed on the best technical and financial value offered. In adjudicating the tenders, in addition to price, account will be taken of:

- Rated (guarantee) operating efficiency offered to be specified in the data sheets to be submitted with this tender;
- Equipment offered;
- Delivery period;
- Ease of operation and maintenance;
- Technical resources and previous project experience;

- General soundness and robustness of design;
- Reliability of components;
- Availability of spares and after sales service; and
- Any special conditions or qualifications put forward by the Tenderer.

2.2. Materials of Construction

2.2.1 Materials

Materials						
Medium	Raw Water (option 1)	Raw Water (option 2)	Potable Water (option 1)	Potable Water (option 2)	Sea Water (option 1)	Sea Water (option 2)
Volute casing	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Casing wear ring	S.G. Iron	S.G. Iron	TBA	TBA	TBA	TBA
Impeller	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Impeller wear rings	Aluminium bronze	Stainless steel	TBA	TBA	TBA	TBA
Pump shaft	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA
Shaft protecting sleeve	High tensile steel	High tensile steel	TBA	TBA	TBA	TBA

2.2.2 *Corrosion protection*

Corrosion protection is to be advised. Contractor is to selects most appropriate corrosion protection technology when determining cost.

3. TESTING AND COMMISSIONING

3.1 Factory acceptance tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

The Purchaser or his representative shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.

The Purchaser or his representative shall reserve the right to witness all tests (as required and indicated on the data, if given ,sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks notice shall be provided before such tests are undertaken.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.

Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

3.2 Site acceptance tests

Each pump shall be subject to a mechanical commissioning run to ensure that it is operating in accordance with its intended design duty and that there is no undue noise, vibration or excessive heating of the units.

3.3 Spares

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier’s recommendations. Maintenance intervals of major and minor services are to be included.

4. DESIGN

4.1 General

4.1.1 *Characteristic Curve*

The pumps are to be selected so as to have stable, non-overloading characteristic curves.

Pump characteristic curves shall show head, efficiency, power demand and NPSH required, plotted against discharge flow rate in metric units at the rated impeller diameter and speed required to satisfy the rated (guarantee) duty.

Measurement	**Preferred Unit**	**Symbol**
Differential head	Meters	(m)
Discharge flow	Litres per second	(l/s)
Efficiency	Percent	(%)
Power absorbed	Kilowatt	(kW)
NPSHr	Meters	(m)
Impeller diameter	Millimeters	(mm)
Speed	Revolutions per minute	(rpm)

The performance curves shall indicate pump performance characteristics at maximum, minimum and rated impeller diameters.

4.2 Prime movers

4.2.1 *Defined operating conditions*

Delete the Sub-Clause and substitute:

The prime movers power output rating shall equal or exceed at least the following margins according to the pump's absorbed power demand at the rated (guarantee) point.

Margin	Description	Value
50%	For pumps requiring up to	2 kW
40%	For pumps requiring from	2 to 5 kW
30%	For pumps requiring from	5 to 10 kW
20%	For pumps requiring from	10 to 30 kW
15%	For pumps requiring from	30 to 100 kW
10%	For pumps requiring	Over 100 kW

Where a unit may be subjected to operating at a run-out duty point condition, the power output rating of the prime mover shall be at least 5% greater than the power absorbed by the pump at this point.

4.3 Critical speed, balance and vibration

4.3.1 *Balance and vibration*

Add to the Sub-Clause:

Rotating elements shall be statically and dynamically balanced according to ISO 1940-1:2003 to a balance quality grade of G2.5. Balancing certificates shall be submitted where specified, in an approved format.

Failure to achieve the vibration limits specified may render the equipment liable for rejection. The Contractor shall be responsible to rectify the equipment to achieve the specified limits at his own expense.

5. MECHANICAL FEATURES

5.1 Dismantling

The manufacturer/supplier must include for and indicate in their offer any special tools required for operation and or maintenance of the pumping units.

5.2 Impellers

5.2.1 *Impeller design*

Vortex type with hardened edges.

The rated impeller diameter shall not exceed 95% of full diameter. Similarly the rated impeller diameter shall not be less than 105% of the minimum diameter.

Pumps that are required to handle raw sewage or similar medium shall be capable of passing solids corresponding to an 80 mm diameter sphere as well as rags, paper and other stringy material without clogging.

5.3 Shaft Sealing

5.3.1 *General*

The preference for either packed glands or mechanical seals shall be specified in the data sheets. If no preference is stated the supplier shall provide his standard design arrangement or alternatively advise otherwise.

5.4 Nameplate

Nameplates shall be securely attached to the pump.

The minimum information required on the nameplate shall be name (or trademark) and address of the manufacturer or supplier, identification number of the pump (for example, serial number or product number), model type and size, rated (guarantee) flow, rated (guarantee) head, rated speed and actual impeller diameter.

5.5 Shop inspection and tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes.

6 MEASUREMENT AND PAYMENT

6.1 Design and supply

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

Measurement of payment will be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rate shall include for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, in complete working order.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M7: VALVES

SECTION M7001: GENERAL VALVES

TABLE OF CONTENTS

SERIES M7: VALVES

SECTION M7001: GENERAL VALVES

1. SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of valves.

2. DESIGN SPECIFICATION

2.1 General

This specification covers valves required to be used on the more common applications. Where special valves are necessary for specific applications, the Tenderer must select suitable valves and provide details with his tender submittals for approval by the Engineer.

2.2 Construction and design

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

Valves shall be double-flanged unless unavailable or otherwise specified.

Valves and their method of actuation shall be designed to provide operation under the full pressure rating of the valve.

2.3 Operating direction

The handwheel, lever, etc. on valves, valve actuators and valve gearboxes shall be clockwise closing unless otherwise specified.

2.4 Position indication

All valves, including valves with gearboxes and valves with actuators, shall be provided with indication of current position as well as indication of closing and/or opening direction. Valves with configurations which make this information apparent will be acceptable.

2.5 Corrosion protection

The specific application shall be taken into account in the corrosion protection of valves.

Cast iron valve components, including valve bodies, shall be protected with System - Fusion Bonded Epoxy.

2.6 Fasteners

Valve and valve gearbox fasteners shall be of grade 316 stainless steel.

3. MATERIALS OF CONSTRUCTION

3.1 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:

The valves shall comply with SANS 664 or SANS 665, Class 10 or higher as required.

The valves shall be double flanged.

Valve bodies, handwheels and bonnets shall be manufactured from spheroidal graphite iron, free from blow holes and carefully fettled after casting to remove surface imperfections. Spindles shall be manufactured from or stainless steel or equal approved material according to the duty requirements. The body shall be provided with channel guides and the gate shall be provided with shoes. Guides and shoes shall be of copper alloy or stainless steel and shall guide the gate along the complete travel distance. Spindle seals shall be of the nitrite rubber 'O' ring type with bush insert and provided with an external scraper ring. Replacement of the seals shall be possible with the valve under pressure.

Fixing lugs for end of travel limit switches shall be provided.

Valves shall have rising spindles unless otherwise specified or necessary. Non-rising spindle valves shall be fitted with indicators showing the valve opening position.

Hand-wheel 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.

Extensions spindles shall be manufactured from 316L stainless steel. Headstocks shall be manufactured from stainless steel 316L steel or cast iron and to a pattern approved by the Engineer.

Valves larger than DN 150 shall be provided with bypass arrangements.

Valves larger than DN 250 shall be provided with doors for inspection and cleaning.

3.2 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 SANS 664 or SANS 665, Class 10 or higher as required.

The valves shall be double flanged. 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.

Valve bodies, handwheels and bonnets shall be manufactured from spheroidal graphite iron, free from blow holes and carefully fettled after casting to remove surface imperfections. Spindles shall be manufactured from or stainless steel or EN57 or equal approved material according to the duty requirements. At least two spindle seals of the nitrile rubber “O” sealing rings in a corrosion resistant housing shall be provided, along with one nitrile rubber wiper ring to prevent the ingress of dirt. Replacement of the seals shall be possible with the valve under pressure.

Handwheels shall be of cast-iron.

Fixing lugs for end of travel limit switches shall be provided

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.

Valves larger than DN 150 shall be provided with bypass arrangements.

3.3 Knife gate valves

Knife-gate valves must be used on water sludges as well as on primary, waste activated and digested sludge duties. They shall also be used on other high solids application and may be used for duties specified under Clause "Cast Iron Gate Valves with Resilient Seals".

Valves shall be Insamcor HDH CI STD, or equivalent, with cast iron bodies, stainless steel blades, cast handwheels, and no carbon steel parts.

Valves for water sludges shall be anti-clockwise closing. Valves for primary, waste activated and digested sludges shall be clockwise closing.

Valves shall have chamfered blade edges and resilient body seals, and may have either rising or non-rising spindles. Gate position indication shall be provided if the overall design does not make this apparent. The blade shall be loaded through its central plane during opening and closing and this shall be achieved by the use of a clevis link or similar.

Blade scrapers shall be incorporated to protect the body seal and valve chest. As the valve is opened, the scrapers shall clean the blade surfaces before these contact the body seal. The scrapers shall be of a non-elastomeric, non-metallic material and shall be designed to cause minimal damage to the blade.

Valves shall be droptight in either flow direction. 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.

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 in accordance with System - Fusion Bonded Epoxy.

Valves shall be double-flanged and shall suit the standard flange rating but may incorporate drilled and tapped fastener holes (the type of valve which is clamped between two flanges will be considered for acceptance only in positions where it is very likely that the pipe or flanged item on either side will never 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.

3.4 Butterfly valves

Butterfly valves are for the use on air, gas and clean liquid duties and for the use on raw and potable water duties, shall comply with SANS 1849.

Butterfly valves shall be of the resilient seal type with suitably lined cast iron body and a lined or 316 stainless steel blade. Valve shafts and thrust pads for cast iron valves shall be of stainless steel 316L and seating rings of gun-metal or stainless steel 316L, or approved synthetic material to suit the application. Valves, except where stated, shall be resilient seal type with neoprene blade seal, suitable for the working pressure. Bearing bushes are to be of 'Vesconite,' Teflon or similar approved material and gland seals of neoprene. Hand lever valve actuation with a locking system for incremental valve setting from fully shut too 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.

Valves shall be air, gas and water tight when closed.

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.
The valves shall be installed with horizontal disc shafts.

3.5 Check valves

3.5.1. General

A shut-off valve shall be installed downstream of each check valve.

The check valve installation shall ensure that flaps are able to open fully without being impeded by, for example, a shut-off valve, bend or pipework internal lining. Where a check valve is located close to another valve, an intervening spool piece with a minimum flange-to-flange length of 1,5 times the valve diameter shall be provided.

Bronze swing type check valves may be used for pipework up to DN 50.

3.5.2. Check valves for water

Check valves for treated water and raw water duty shall be of the double-flap, positive-closing type.

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. The gate, swing arm and hinge shall be designed to carry full shock loading on closure. Seals shall be of resilient material. The axis of rotation of the flaps shall be vertical, pins shall be of 316 stainless steel 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. The valves shall seal effectively under all operating conditions and the design shall be such that the gate rests against the seat in the absence of flow or of differential pressure without the aid of the springs or external counterweights.

Positive, external indication of the position of both plates shall be provided.

3.5.3. Swing check valves

Swing check valves shall be used on all sewage, sludge or similar applications. Valves for use with sewage, effluent or sludge shall be self cleansing at the base of the gate.

Swing check valves shall be flanged, shall be of all iron construction suitable for a working pressure of at least 1 000 KPa, and shall be fitted with a side lever and adjustable weight. External levers and counterweights shall be fitted to the hinge shaft which shall be extended through the valve body and provided with nitrile rubber 'O' ring seals which may be replaced with the valve under pressure. The level and counterweight shall be provided with facilities for adjusting the angle and weight positions.

Orientation of the valve installation shall comply with the manufacturer's recommendation.

3.6 Pinch valves

All isolating valves at pump installations to have rising spindles.

Pinch valve sleeves shall be manufactured form high strength synthetic fiber or steel cord reinforcement. The sleeve liner is to be natural rubber. The sleeves are to be tested to twice their maximum working pressure and supplied with a test certificate. The closing mechanism is to be design for ease of operation under pressure. The valve is to be supplied with an indicator for open/close indication. Where called for, pinch valves may be used as control valves with either electro-mechanical, pneumatic or hydraulic operation.

3.7 Bronze isolating valves

May be used for isolating duties on clean air and liquid duties up to DN 50.

Bronze gate valves shall be to SANS 77 Ball or plug valves of appropriate construction may also be used where preferred.

3.8 Rubber diaphragm valves

To be used on sludge and other dirty or corrosive liquid duties requiring valves up to DN 350. May also be used on clean liquid duties.

Rubber diaphragm valves shall preferably be of the straight through type with the diaphragm made of natural rubber.

This type of valve shall not be used on the suction side of pumps or on any line subject to vacuum.

3.9 Needle valves (above DN 150)

Needle valves 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 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.

3.10 Air valves

Air valves for water shall be of the non-slamming type, Vent-O-Mat, ARI or equivalent.

Air valves for sewage and similar duties shall be specifically designed for the application.

Air valves shall be installed above pockets designed to collect air. The pockets shall be designed in accordance with the requirements for nozzles in pipe-work. The diameter of the nozzle shall be at least half the diameter of the parent pipe work.

Air valves shall preferably be flanged and shall be provided with isolating cocks.

3.11 Corrosion Protection

Corrosin protection shall be carried out strictly in accordance with the Standard Specifciation for General Corrosion Protection.

All vavles unless otherwise specified are to conform to System – Fusion Bonded Epoxy.

4. TESTING AND COMMISSIONING

4.1 Tests on completion

Performance testing will be carried out on the equipment after commissioning and adjustment. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

The tests will be performed on the equipment over a single 8 hour shift. They shall consist of the following:

1. Smooth and efficient operation of the valves.

2. Appropriate closing direction of the valves according to the above specification.

3. The torque doesn't exceed the torque stated in the data sheets.

The equipment will be considered acceptable when:

1. The equipment meets the duty requirements as defined in this section of the Specification and stated in the data sheets.

During the Defects Liability Period.

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M7 VALVES

SECTION M7002: TELESCOPIC BELL-MOUTH VALVE

TABLE OF CONTENTS

SERIES M7 VALVES

SECTION M7002: TELESCOPIC BELL-MOUTH VALVE

1. SCOPE

This specification covers the supply, delivery, off loading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order for telescopic bell-mouths. Under full load, the yield strength and tensile strength of the materials must be within their limits.

2. DESIGN SPECIFICATIONS

Each telescopic bell-mouth shall be fitted with manual operated hand-wheels. The vertical travel shall be such that a distance from the top of the bell-mouth to 200mm below top water level (TWL) and 100mm above TWL can be accommodated in the arrangement. A baffle plate shall be incorporated to eliminate splashing sludge out of the chamber.

Each valve shall be fitted with adjustable travel limits and the torque on the hand-wheel shall be sufficient to function without overloading.

3. MATERIALS OF CONSTRUCTION

All piping shall be manufactured in 316L s/s, and the spindle shall be of a non-corrodible material suitable for the duty, with square thread spindle nuts manufactured in bronze or gun metal. The spindle shall be fitted with a clear polycarbonate weatherproof cover to visually see the degree of opening. Hand wheels shall be mounted such that the bell-mouths can be easily controlled by the hand wheel mounted on the headstock manufactured from either cast iron or aluminium. All mounting brackets and holding down bolts for the hand wheel shall be manufactured from 316 stainless steel. Proposed details for the hand wheel control mechanism and manner of operation are to be submitted with the tender.

The bell-mouth essentially consists of a pipe within a pipe. No metal-to-metal contact shall occur and the seal arrangement on the sliding section shall be suitable for long life in sewage sludge conditions. Should it be required to change the seal, it shall be accomplished without having to remove the complete bell-mouth.

4. TESTING AND COMMISSIONING

Tenderers shall provide sufficient information to permit evaluation of the performance of the equipment. Performance tests will be carried out once the plant is operating and a sum has been included in the Schedule of Prices for conducting these tests.

The test procedure shall be approved by the Engineer and contain the following minimum requirements:

a. Determination of maximum and minimum travel to suit the desludge operation required.

b. Efficient operation of bell-mouths in situ.

c. Testing of hand wheel torque required to operate the valve by one of the operators

The tests shall be undertaken over a period of time, as the sludge in each settling tank requires time to achieve the conditions they will be subjected to. The equipment shall be considered acceptable when the units effectively control the de-sludging operation as specified.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M9 SCREENING

SECTION M9002: HAND RAKED BAR SCREEN

TABLE OF CONTENTS

SERIES M9 SCREENING

SECTION M9002: HAND RAKED BAR SCREEN

1. SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of hand raked bar screens.

2. DESIGN SPECIFICATIONS

2.1 General

The screen must be able to handle various types of suspended solids such as pieces of timber, cloth, string or any other fibrous materials, metal objects, rocks, sheets of paper and any materials which are likely to be present in the influent under typical South African conditions. The
Bar spacing must be between 35-45 mm.

The hand raked bar screen shall be sufficiently robust to prevent bending and deformation of the bars under normal operating conditions and to have the required bar profile for minimal head loss. The bar spacing is to be as specified in the technical data sheets. Recesses in the walls and floor of the concrete channel are to be cast by the civil contractor for the screen to be of a minimum obstruction to the flow. The top of the screen is to be level with the top of the channel when installed. The civil contractor is to grout in the screen once installation has been completed. A hand rake with teeth in proportion to the bar spacing is to be provided along with the screen.

3. MATERIALS OF CONSTRUCTION

3.1 General

The screen is to be fabricated from stainless steel 316L and to be pickled and passivated. All fasteners are to be of stainless steel 316L. The screen must be mounted at 70 degrees.

3.2 Name plates

A name plate, placed in a viewable position, is to be provided with the following information:

Manufacturers name

Supplier’s name

Serial number

Type

4. TESTING AND COMMISSIONING

Performance testing will be carried out on the equipment after commissioning and training of the Council's employees. The tests will be performed on the equipment over a single 8 hour shift.

These tests shall consist of the following:

- Efficient operation of the screen under all operating conditions including simulation of capability using rocks, wood, metal, and other debris (within reason and simulating expected debris in the incoming flow) deposited into the channel ahead of the screen; and
- Fast and efficient removal of screenings with the use of the hand rake without the teeth of the rake jamming in the bars of the screen.

The equipment will be considered acceptable when:

- The above tests have been sufficiently met.

During Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

SECTION M10001: FLUID CONTROL EQUIPMENT

TABLE OF CONTENTS

SERIES M10 MECHANICAL FLUID CONTROL EQUIPMENT

SECTION M10001: FLUID CONTROL EQUIPMENT

1. SCOPE

This specification covers the design, supply, delivery, off loading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order for penstocks. The equipment is to be designed in accordance to DIN Spec 19704. Under full load, the yield strength and tensile strength of the materials must be within their limits.

2. DESIGN SPECIFICATION

2.1 General

Equipment is to generally adhere to the below unless otherwise specified:

Equipment shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L Equipment is to be manufactured in stainless steel 316 in coastal areas or where the environment is highly corrosive. It is to be designed for minimum leakage and shall be provided with headstocks and rising spindles with wall mounted brackets. All equipment is to be hand wheel operated. Bevel gearboxes shall be provided. Gates shall move freely and smoothly in the frame and adjustment shall be provided using wedges manufactured from stainless steel or other approved non corrodible material. The wedges shall have a profile which will prevent seizure after long periods of immersion in a closed position. Frame sealing shall be arranged with the use of replaceable bulb section neoprene strips, and seals manufactured from a similar ultra violet resistance material shall be provided on the upstream face of all moving faces. The gate guides on channel penstocks shall extend upwards to fully accommodate the gate when fully opened.

Gate lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread.

Covers shall be provided for the spindles. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

2.2 Wall mounted sluice gates

Wall mounted sluice gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Wall mounted gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Wall mounted sluice gates are to be designed for minimum leakage and shall be provided with headstocks and rising spindles with wall mounted brackets. The wall mounted gates are to be hand wheel operated. Bevel gearboxes shall be provided. The gate shall move freely and smoothly in the frame. The frame sealing for all sides of the wall mounted sluice gates shall be arranged with the use of replaceable bulb section neoprene seals of the “music note” or “J” types. The tenderer is to state if the sealing is “on” or “off” seating on the technical data sheets.

2.3 Twistlock gates

Twistlock gates are similar to wall mounted sluice gates but are of a smaller size and where they are to be hand mounted. It will be able to be locked in any partially opened position by a cam mechanism forcing the gate against the frame. The same action is to be used for closing the gate. A head of 3 m for seating and a head of 2 m for unseating may be used. They may be fabricated from cast iron, cast stainless steel or mild steel with corrosion protection. Bronze seating faces are to be used.

2.4 Channel gates

Channel Gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Channel gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Channel gates are to be designed for minimum leakage and shall be provided with head frame and rising spindles. The channel gates are to be hand wheel operated or otherwise stated. Bevel gearboxes shall be provided. The gate shall move freely and smoothly in the frame. Channel gate seals are to be manufactured from Neoprene. Angle type neoprene is to be used for the vertical members while compression type is to be used in the invert.

Channel gate lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread. In cases where the spindle is excessively long due to a deep channel or higher than usual head frame, the spindle is to be supported by guides to prevent buckling. Twin lifting spindles with interconnected gearboxes are to be used for very wide gates.

Covers shall be provided for the spindles on all channel gates. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

The frame of the channel gate is to be embedded into the channel. Provisions for blockouts in the channel are to be made by the civil contractor. Once the channel gate has been installed the civil contractor is to complete the necessary grouting in.

2.5 Weir gates (Downward Opening Weir Gates and Tilting Weirs)

Downward opening weir gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L Downward opening weir gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive. Downward opening weir gates are to be designed for minimum leakage and shall be provided with head stock, rising spindles and wall mounts. The weir gates are to be hand wheel operated. Bevel gearboxes shall be provided. Sealing will be achieved through ultra violet resistant neoprene seals of the “tri angular” or “J” types between sections and the installed arrangement shall provide an effective seal under all depths of immersion.

If the head is greater than the height of the opening, four sided seals are to be used if the flow is to be completely shut off. Otherwise three sided sealing is to be used.

If the width of the gate is to be significantly greater than height of the gate, side extensions may be added to increase the effective height of the gate. In the case of not being able to add extensions to the gate, double lifting spindles with synchronized gearboxes are to be used.

Tilting weir gates shall be of robust construction suitable for the required duty and shall be fabricated in stainless steel 316L. Tilting weir gates are to be manufactured in stainless steel 316L in coastal areas or where the environment is highly corrosive Tilting weir gates are to be designed for minimum leakage and shall be provided with head stock, rising spindles and wall mounts. The weir gates are to be hand-wheel operated. Bevel gearboxes shall be provided. Along the hinged section, flat neoprene seals are to be fitted the installed arrangement shall provide an effective seal under all depths of immersion. Vertical travel shall not be more than 500 mm. A centrally mounted spindle is to raise and lower the tilting weir gate and it is to be hinged at the bottom.

Downward opening and tilting weir gates lifting spindles shall be of adequate diameter to open and close the gate against resistance without excessive deflection. The lifting nut shall be of bronze or gun metal with thread length equal to at least twice spindle diameter and cut with mating thread.

Covers shall be provided for the spindles on all downward opening and tilting weir gates. The covers shall accommodate the full range of travel of the spindle and shall include external brass position indicators and be manufactured from robust polycarbonate material and provided with stainless steel 316L mounting flanges bonded to the covers.

2.6 Hand stops and stop logs

They are to be for manual installation and removal by two operators and the mass of each section shall not exceed 25 kg. The maximum width is to be no more than 1000 mm.

Provision shall be made for the easy attachment of lifting hooks to the hand stop/stop log eyes under submerged conditions and two sets of lifting hooks shall be supplied under this contract.

Sealing will be achieved through ultra violet resistant neoprene seals between sections and the installed arrangement shall provide an effective seal under all depths of immersion.

The contractor shall design and supply a permanent frame manufactured from Aluminium sections to enable the storage and locking of hand stops.

The frame of the hand stop is to be embedded into the channel. Provisions for block-outs in the channel are to be made by the civil contractor. Once the hand stop has been installed the civil contractor is to complete the necessary grouting in.

2.7 Flap gates

Flap gates are used to prevent reversal of flow at the end of pipes or walls. Gates are to be double hung by stainless steel pins in bronze bushes.

Smaller sized flap gates are to be fabricated in cast iron or cast stainless steel and to have bronze or stainless steel sealing faces. Larger sized flap gates are to be fabricated from stainless steel, or adequately corrosion protected mild steel. Neoprene seals are to be used.

2.8 Sluice valves

Sluice valves are cast into the floor of reservoirs and tanks for draining them. They may be supplied in cast iron, cast steel, stainless steel, corrosion resistant steel or mild steel. Bronze, neoprene or stainless steel may be used for the seats. The operation is to be by means of a hand wheel.

2.9 Hand flushing valves

For draining fluid from tanks, hand flushing valves are appropriate for up to 3m of head and are to be of the quick opening lever operated type. They may be fabricated from either cast iron or cast iron stainless steel and be supplied with bronze seats.

2.10 Ground water relief valves

Ground water relief valves, where necessary, are cast into the floor of reservoirs, tanks, canals, etc. to relieve pressure caused by ground water. The maximum pressure head of 4 m is the recommendable allowable pressure. The body is to be fabricated from cast iron or cast stainless steel. The flexible disc and sealing disc are to be neoprene.

2.11 Fasteners

All fasteners are to be manufactured from stainless steel 316L

2.12 Electric actuators

Where electric actuators are to be used, they are to conform to the below details and to the relevant specification for actuators.

Electric actuators shall be adequately sized to accommodate the seating and unseating requirements. Travel duration from open to close or close to open position shall not be greater than 60 seconds for electric actuators.

The differential between supply and feedback signal on electric actuators shall not exceed 0,05 mA.

Status feed back contacts are to be provided for remote indication of:

Open/closed position

Torque trip at intermediate position
Actuator fault

Hand operation

2.13 Name plates

A name plate, placed in a viewable position, is to be provided with the following information:

Manufacturer’s name

Supplier’s name

Serial number

Size and type

3. MATERIALS OF CONSTRUCTION

3.1 Corrosion protection

Corrosion protection shall be carried out in accordance with the requirements of the General Specifications for General corrosion Protection and to the following systems:

- Stainless steels and 3CR12: Pickled and passivated
- Mild steel : System - Fusion bonded epoxy coated
- Aluminium : Anodised
- Hand wheels : System A/1
- Electric actuators : System B/1

4. TESTING AND COMMISSIONING

All channel gates, penstocks weir gates, tilting weirs and hand stops shall be checked for good installation and easy and correct functioning. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Performance testing will be carried out on the equipment after commissioning, adjustment and training of the Council's employees.

The tests will be performed on the equipment over a single 8 hour shift.

The tests shall consist of the following:

Correct operation.

Full opening and closing of the gate. Manual operation of a gate is to be achieved by one person at all times. Where there is actuation, the actuator is to achieve full opening and closing of the gate.

Visual inspection of gate sealing at their closed positions with liquid at the maximum level.

Electrical power use with a calibrated kWh meter (if equipment is actuated).

Installation and removal of hand stops under dry and maximum flow conditions.

The equipment will be considered acceptable when:

1. The equipment meets the duty requirements as defined in this section of the Specification.

2. The tests defined above prove the acceptable operation of the equipment.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M14 DISINFECTION AND CHEMICAL DOSING
SECTION M14001: STANDARD SPECIFICATION FOR SMALL TO MEDIUM SIZED GASEOUS CHLORINATION FACILITIES

TABLE OF CONTENTS

SERIES M14 DISINFECTION AND CHEMICAL DOSING

SECTION M14001: STANDARD SPECIFICATION SMALL TO MEDIUM SIZED GASEOUS CHLORINATION FACILITIES

1. Scope

This section of the Contract covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of a small to medium sized gaseous chlorination system to dose chlorine at a rate not exceeding 3 kg/h. The equipment includes but is not limited to the following:

- Chlorinators complete with ancillary equipment; pipe work and fittings
- Manifold for chlorinators for chlorine storage drums including feed pipe work.
- Support cradles and mass indicators for monitoring chlorine inventory.
- Overhead chlorine drum hoist and associated equipment
- Motive water pumps, pipe work and fittings
- Ambient chlorine detection equipment to detect leaks
- Chlorine residual analyser(s) to control the dosing rate
- Local control panel (LCP), including all cabling to chlorine and ancillary equipment within the chlorine building
- One set of safety equipment for the chlorination facility
- Treated water flow meter

The installation is to comply with all the requirements of SANS 10298:2005. The details of the equipment required are given in the data sheets that form part of this specification. The equipment supplied shall form a complete working system and shall be suitable for integration with and efficient operation in combination with equipment to be supplied under other sections of this Contract as described elsewhere in this document.

This specification is to be read in conjunction with the Data Sheets that form part of this specification. All equipment described in this specification is to be provided unless specifically noted to the contrary in the Data Sheets.

2. Design

2.1. General arrangement and description

Chlorine in solution will be dosed into the treated water at the indicated dosing point. The chlorinator shall be of the wall mounted vacuum type, of simple and rugged design. Pressure reducing valves, indicators calibrated in kg/h, injector assembly and diffusers if applicable are to be part of the associated equipment to be supplied. The chlorinators are to automatically shut off in the event that the motive water is not supplied to the system. The chlorinators are to be provided with all necessary equipment for safe and efficient dosing.

Chlorine will be extracted from the chlorine storage drums located in the chlorine storage room. The drums are to be mounted on cradles with mass indicators. The chlorine supply drums are to be connected to a common manifold and be provided with manual isolating and inter-connecting functions. Automatic change over from one drum to the next is to commence once a drum empties during normal operation.

Treated water for motive water purposes will be provided at a point outside the chlorine house as indicated on the drawings. The Contractor shall be responsible for connecting to the terminal point of the pipe and providing the necessary filters and pressure reducing isolating and valves for effective control of feed water to the injector unit. Tenderers shall determine the quantity and pressure of motive water required.

Heaters shall be provided on the discharge pipe from each chlorine drum to eliminate liquid chlorine and frosting from occurring provided if required by the maximum dosing rate and ambient winter temperatures at the site.

Particular care shall be taken to obviate the possibility of leakage of chlorine gas under all possible conditions likely to be encountered during operation of the plant. All materials used in the manufacture of plant and pipe work shall be resistant to the corrosive action of chlorine either in gaseous or solution form. Any materials showing signs of corrosion during the maintenance period will be rejected and shall be replaced by the Contractor at his own expense with plant or material which is resistant to corrosion as shown by the retest, which remedial work shall continue until complete satisfaction is given to the Engineer.

2.2. Duties

Chlorine is required for disinfection of the treated water. The chlorinators shall be fed off chlorine drums, of which two will be connected at any one time. The chlorinators will be operated in a duty-standby arrangement. The required motive water shall be taken from the treated water system. Should higher pressures be required than the supplied motive water, tenderers are to include motive water pumps to meet the required pressure and duty.

The chlorinators shall have a turn down ratio as indicated in the Data Sheets. Automatic adjustment of the chlorine feed rate shall be provided in proportion to the treated water flow rate as measured by the flow meter if required by the Data Sheets. The flow measurement value will be in the form of a 4-20 mA signal and the dosage controlled by the PLC. As either the flow rate varies and/or the dosage rate is changed, the total flow rate of chlorine shall be set proportionally.

The local control panel shall provide analog output signals to indicate system pressure, weight of chlorine drums, and a digital alarm signal for unacceptable ambient chlorine levels.

3. Equipment Specifications

3.1. Chlorine storage support cradles and mass indication

Two support cradles are to be fabricated from mild steel with a mass measurement system integrated into the frame to measure the mass of the cylinders. Where load cells are specified in the Data Sheets these cells shall provide a 4-20 mA output converted to kilograms.

3.2. Chlorine drum crane

A hoist and trolley shall be provided, suitable for unloading, loading and moving the chlorine drums inside the chlorine building. It shall be suitable for a safe working load as indicated in the data sheets. It shall comply with the requirements of the Machinery and Occupational Safety Act No.6 of 1983, and those sections of the Factories Machinery and Building Works Act No. 22 of 1941 not repealed by Act No. 6 of 1983.

The crane shall be designed in accordance with the latest editions of BS 466 and BS 2573: Part 1. Refer to the standard specification for lifting equipment.

Where an electrically driven hoist is specified in the Data Sheets, it shall be operated from pendant-type controls, hanging no higher than 1200 mm from the floor of the building. The crane shall be marked with its safe working load clearly legible from floor level.

3.3. Pipe work, valves and fittings

The construction of all chlorine pipelines shall be in accordance with the general requirements for gases under pressure and shall comply with the Occupational Health and Safety Act (OHS Act), 1993 (Act No. 85 of 1993) and the Mines and Works Act, 1956 (Act No. 27 of 1956). All pipe work, valves and fittings are to be suitable for a chlorine environment and be rated 1.5 times the maximum allowable pressure in the system. Chlorine solution and motive water pipe work shall be uPVC pressure piping and comply with SABS 966 and be Class 16. All isolation valves shall be of the quarter turn ball valve type. Valves connecting the flexible connectors to the drums shall be needle valves.

3.4. Chlorinator

The chlorine metering system will operate under vacuum produced by an injector on the feed water supply system. The injector shall dispense the chlorine solution into the water at the dose point. The equipment shall be such that no chlorine gas is discharged into the atmosphere. The chlorinator shall shut off automatically when the feed water supply stops.
The chlorinator shall comply with the following:

- The cabinets shall be manufactured from fibreglass or other material not subject to corrosive attack by chlorine gas and shall be floor mounted.
- The cabinet cover shall be removable, giving clear access to all components inside the chlorinator. All controls shall be eye level.
- The unit shall be equipped with glass flow metering tube graduated in kg/hr. The flow of gas through the tube shall be infinitely adjustable by manually setting the flow control valve to the desired flow rate.
- The unit shall be fitted with gauges to indicate the gas inlet pressure to the pressure regulator, the injector vacuum and the motive water pressure.
- All gas and solution piping, valves and the like to connect the various items of equipment and convey the solution to the point of application including feed water piping and fittings shall be provided.
- The equipment supplied shall be capable of automatic adjustment in accordance with flow to be dosed as indicated by a 4 to 20 mA signal from the flow meter or control system.

The following accessories are to be supplied with the chlorinator:

- One spare metering tube for the applicable range;
- 50 mm dial pressure gauge and gauge cock;
- Moisture trap/filter assembly;
- Gas piping manifold for connection of chlorinators to two standard drums;
- Chlorine solution piping to dosing point including diffuser if required;
- Wall-mounted chlorine cylinder instruction chart, mounted in wood/glass frame;
- Wall-mounted plastic engraved warning board.

3.5. Injector feed water and dosing pipe work

The chlorinators shall obtain motive water for the injector feed from the treated water provided at the site. The motive water provided may contain small amounts of suspended solids and an in-line Y-strainer shall be provided between the motive water take off point and the chlorine dosing plant. Chlorine solution shall be dosed into the water at the dosing point shown on the drawings. The Limit Of Contract for the pipe work from the chlorine building to the chlorine dosing point will be as shown on the drawings. The Contractor shall connect to this pipe immediately upstream of the dosing point. Where required by the installation the Contractor shall provide the diffuser pipe work at the injection point.

The motive water installation shall be complete including all isolating valves and fittings and shall terminate as shown on the drawings.

3.6. Automatic Change over Panel

The automatic change over panel shall automatically change over from the duty to the standby bank of drums when the pressure in the duty bank drops to a preset pressure. Change over shall occur in such a manner as to prevent backflow of chlorine. The change over panel shall provide a clear indication as to which bank of drums is in service and that change over has occurred and the information shall be indicated on the HMI linked to the existing SCADA where specified in the Data Sheets.

3.7. Safety equipment

A Drager or equally approved full face gas mask and respirator, suitable for operation with chlorine gas, with two replacement canisters, two pairs of gloves and one drum isolating valve repair kit shall be provided in a waterproof casing mounted on the outside wall of the chlorine building at the entrance to the building.

A chlorine leak detector shall be mounted in the chlorine drum room complete with sampling fan, gas indicator and audio-visual alarm. The apparatus shall measure the concentration of chlorine in the atmosphere at a level of 300 mm above floor level. The concentration of chlorine in the atmosphere shall be indicated on a digital readout mounted in the chlorinator room and at the HMI. An alarm shall be indicated both locally in the equipment room and at the panel HMI when the concentration of chlorine in the atmosphere exceeds a preset concentration.

A combination safety shower/eyewash shall be provided located at a position of not more than 15 m from the chlorine building. The facility shall comply with the U.S. ANSI Standard Z358.1-2009 for emergency eyewash and shower equipment. The shower shall utilise potable water and comply with the following primary requirements:

- The emergency shower shall deliver a pattern of water with a diameter of at least 50 cm at 150 cm from the shower head.
- The shower head shall be located between 200 and 240 cm from the floor. The minimum volume of spray should be 75 litres/minute for a minimum time of 15 minutes.
- The shower shall be able to be activated in less than 1 second and remain operational without the operator's hand on the valve. The valve should not be more than 170 cm above floor level.
- The eyewash shall deliver fluid to both eyes simultaneously at a flow of not less than 1.5 litres/minute for 15 minutes.
- The eyewash shall be located between 85 and 115 cm from the floor and a minimum of 15 cm from the wall or nearest obstruction.

3.8. Signage

An instruction chart in the languages listed in the Data Sheets is to be supplied by the contractor which gives clear instructions as to the operation and maintenance of the chlorine equipment, chlorine drums, change-over procedure, gas leakage and detection along with all safety and first aid measures. An instruction sign board with pictures is to be included along with the instruction board in the stated languages. The instruction charts shall be mounted on the wall of the chlorine building.

The applicable National Occupational Safety Association (NOSA) and emergency procedures as well as the South African Chlor-Alkali Manufacturer's Association (SACAMA) wall charts shall be appropriately displayed. The following signage shall also be provided:

- Symbolic safety chart (2 No) mounted at the entrance to the cylinder and equipment rooms indicating the following:
    - No unauthorised entry

- Warning: Poisonous substance hazard
- Mandatory: eye protection, face protection, respiratory protection, hand protection, foot protection
- Information: Direction to safety shower and eyewash
- A works instruction chart with basic instructions on the use of the system.
- An emergency plan chart available from Polyfin

The wall charts shall be weather resistant, non-fade and durable.

3.9. Scrubber System

A scrubber system shall be provided and shall comprise of one or two caustic gas scrubbers with sufficient capacity to deal with the leakage of one chlorine drum without recharge. It shall be provided with sampling points to draw caustic samples for monitoring purposes.

The gas extraction system and piping shall be suitable for the intended duty and shall have sufficient capacity to recycle the chlorine laden air from the drum store through the gas scrubber vent.

The invert of the suction piping shall be located approximately 300 mm above the drum room floor with evenly spaced drop pipes just above floor level. The diameter of the drop pipes shall be suitably sized to ensure and even draw from each drop pipe.

The equipment supplied shall include:

- The gas scrubbers
- All suction piping to draw from the chlorine drum store
- Delivery piping from the extraction blower to the scrubber and from the scrubber to the chlorine drum store
- The extraction blower or fan regardless of whether a scrubber is required shall be provided. Extraction fans are required on the chlorine storage and operations room. The extraction system shall be designed to exchange the air in the room in less than four minutes.

3.10. Control Philosophy

Control automation where required shall be in accordance with the specifications given in the sub-sections below.

3.10.1. Setting of dose rate using the readout of residual chlorine and rate of flow

The total residual chlorine concentration measured by the instruments supplied under the contract shall be used to control chlorine dosing. If the residual chlorine deviates from a preset band, the system shall adjust the dose rate.

The treated water flow rate shall be measured by means of a flow meter to be installed under the contract. In order to maintain process stability, each adjustment of the chlorine dose rate shall take place after a time period allowing for the retention time in the system.

3.10.2. Setting of dose rate using the readout of rate of flow

Provision shall be made to enable the operator to set the “base” dose rate at the control panel. The rate of chlorine dosing shall be adjusted automatically in accordance with the change of flow rate as measured by the flow meter, and the preset “base” dose. An alarm shall be provided if the chlorine residual deviates from the preset band.

3.10.3. Mass indication

The mass of chlorine in the duty and standby banks shall be indicated on the HMI.

3.10.4. Chlorine leak detection, extraction fan and gas scrubber

The level of chlorine gas as indicated by the leak detector shall be indicated at the HMI.

When the concentration of chlorine gas in the drum store exceeds a preset level:

- An alarm shall be indicated at the panel and an indicator light shall illuminate at the entrance to the chlorine building and shall remain lit until the concentration drops to a preset low level.
- The chlorine motive water pumps shall stop and chlorination shall cease.
- The gas scrubber shall switch on and continue to operate until the chlorine concentration in the chlorine drum store drops to a preset low level.

3.11. Fasteners

All fasteners are to be suitable for their application in a highly corrosive chlorine environment according to the General Specification. Holding down bolts are to be provided by the contractor.

3.12. Electrical installation and instrumentation

The local control panel is to receive the power feeder for the chlorination equipment as well as the flow measurement signal for flow proportional dosing. The local control panel is to interface with the rest of the plant. The local control panel is to communicate to the control room the pressure in the chlorine system, weight of the chlorine drums and the level of ambient chlorine in the chlorine room. The main electrical contractor is to supply the power to the local control panel. All electrical cabling for supply of power to the chlorination equipment in the chlorine room is to be supplied under this contract.

Switches to activate the extraction fans and lighting shall be located externally near the door. All lights, plugs motors and other electrical fixtures inside the chlorine building shall be corrosion proof in compliance with IP65 to prevent deterioration from chlorine gas.

3.13. Motors

All motors shall have IP55 protection, anti-condensation heaters and be wired for direct online starting.

3.14. Corrosion protection

Corrosion protection shall be carried out in accordance to the standard specification for corrosion protection. Before final fasteners, the final coat of polyurethane enamel is to be applied to all pipe work after installation. The colour coding is to be advised by the engineer.

4. TESTING AND COMMISSIONING

4.1. Operator training

During the testing and commissioning procedure, the Contractor shall train the operators in the operation and maintenance of the equipment. Prior to the commencement of operator training, a draft copy of the Operating and Maintenance Manual shall be available on site. On completion of commissioning, the manual shall be updated in the light of experience gained during the commissioning of the plant and the final copies shall be submitted.

Training shall cover the following aspects:

- The operation of all items of equipment
- Maintenance of the equipment
- Training in safety and emergency procedures
- Fault finding on the equipment
- Training in the operation and maintenance of all items of safety equipment

4.2. Tests on completion

As a minimum, the following shall be undertaken before commissioning:

1. Cleaning and drying of the system
2. Air or nitrogen pressure test to 1,5 times the maximum design pressure.

4.3. Commissioning

All equipment shall be tested to demonstrate its compliance with the specification and the details contained in the Data Sheets. The chlorinators shall be tested throughout the dose range. All instruments shall be correctly calibrated and the repeatability demonstrated. Performance tests of the equipment shall be performed over an 8 hour shift and as a minimum the following shall be undertaken.

1. Measurement of chlorine dosage rate in response to flow signals and dosage settings.
2. Measurement of vacuum induced by chlorine injection unit.
3. Measurement of power absorbed.

The equipment will be considered acceptable if the measured values do not deviate from those stated in the Data Sheets by more than 5% and when:

1. The tests above prove the acceptable operation of the equipment.
2. No chlorine leaks are shown in the delivery pipe work at a pressure of 12 bar.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. Spares and Accessories

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be provided according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

As a minimum the following equipment shall be provided:

a) One spare flow rate meter for each machine
b) One spare flexible tank connection for each machine
c) Three sets of all special gaskets to fit all joints and unions
d) One set of clamps for all hose connections
e) One residual-chlorine comparator employing permanent colour standards or equal approved
f) Two emergency repair kit for chlorine tanks
g) One set of all special tools required for adjustment, operation, maintenance and disassembly. All tools shall be high-grade, smooth
h) A grease gun or lubricating device for each type of grease required
i) Wall mounted steel tool box complete with flat key locks, two keys and tool clips. Tools are to be high-grade smooth forged alloy tool steel.
j) One 120 ml bottle of ammonia

6. Measurement and Payment

6.1. Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit

6.2. Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of:

- Chlorinators complete with ancillary equipment and pipework within the chlorine building;
- Manifold for chlorinators for 1 tonne chlorine cylinders including feed pipe work;

SERIES M20 LIFTING EQUIPMENT

SECTION M20001: OVERHEAD TRAVELLING CRANES

TABLES OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20001: OVERHEAD TRAVELLING CRANES

1. SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of overhead travelling cranes.

2. DESIGN SPECIFICATION

2.1 General

The Tenderer shall inspect the drawings to determine what steps need to be taken for installation of the crane and shall plan work on Site accordingly. Design requirements for installation of the crane rails shall be provided by the Contractor.

Construction of the crane shall be in accordance with ISO 16880, SANS 10160, SANS 10162 and SANS 1431.

2.2 Overhead travelling cranes

The Contractor may use a crane during the installation of other equipment on condition that all testing and certification for the complete lifting installation, including supporting structure, has been successfully completed.

The hoist shall be supported on and travel along a fabricated steel crane beam structure. The crane beam shall be supported on and travel along crane rails. The rails shall be supported along their full length, either on a concrete ring beam or on additional hot-dip galvanised steel beams.

The Contractor's proposed method of fixing the crane rails shall be submitted to the Engineer for approval.

The crane's safe working load rating shall be stated in the tender submission.

The crane long travel, cross travel and hoist shall be electrically-powered or manually operated as stated in the Technical Data Sheets.

The crane duty shall be stated in the Technical Data Sheets.

Unless otherwise stated, the lowest hook level shall be room floor level and all operating chains shall fall to one metre above this level.

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 350 W.

Site welding will not be acceptable. All welding shall be continuous unless otherwise approved in writing by the Engineer. No crevices will be permitted. All welding slag and weld spatter shall be removed and welds shall be ground smooth prior to coating. All welds shall be free of blowholes. Sharp edges resulting from cutting operations shall be rounded to a radius of at least 3 mm and open pockets which are inaccessible for preparation and coating will not be permitted.

The crane beam and end carriages shall be designed with suitable dimensions, wheel spacing 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 and to limit the long travel along 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 properly sealed plummer blocks 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.

The safe working load shall be permanently marked on the crane hook and on both sides of the girder.

The hoist, if powered, shall comply in all applicable respects with the Occupational Health and Safety Act.

An overload prevention device, such as a clutch which slips upon overloading, shall be incorporated.
The bottom hook shall swivel on a ball or roller bearing through 360º and shall be fitted with a safety latch. The bearing shall have a protective skirt.

Lifting chain is preferred, but corrosion protected steel wire rope is acceptable for higher loads.

A chain box for the unloaded length of lifting chain shall be provided.

The crane rails shall be supported on and secured to the concrete or steel gantry beams and shall be installed true to span, level, aligned, and shall be straight to within the permissible deviations given in ISO 16880 over their entire length. The crane rails shall be made from standard rail sections. Rails manufactured from square section steel bar will not be acceptable. Rails shall be joined using fish-plates, with at least four fasteners, to provide a continuous path for the travel of the crane wheels. The rails shall be hot-dip galvanized after all fabrication work.

The distance between rail supports shall not exceed 1 000 mm and supports shall be anchored using grade 316 stainless steel bolts.

Where specified, a personnel platform for two people shall be provided on the crane structure. The platform shall be bolted to the crane beam structure and shall be removable. The steel sections which form the crane beam shall be provided with welded lugs to which the platform shall be bolted. The complete platform and all guard-railing shall be hot-dip galvanised after fabrication. The platform itself shall be designed so that a person standing on it will be able to replace the electric lamps. A hot-dip galvanised steel ladder shall be provided for accessing the platform. The platform floor shall have a minimum width of 500 mm.

2.3 Hoists

Hoists shall be provided with a slipping clutch, or equivalent, which shall ensure that it is not possible to overload the hoist.

Powered hoists shall hold the load upon power failure; i.e. shall feature fail-to-safe braking.

2.4 Fasteners

Crane rail anchor bolts shall be M16 or larger and shall be of grade 316 stainless steel. Fasteners smaller than 12 mm shall be of 316 stainless steel. All other fasteners, including high-tensile fasteners, shall be of stainless steel or shall be hot-dip galvanized.

Before assembly, the threads of all bolts and studs shall be coated with an approved nickel-based, anti-seize corrosion protection compound.

3. MATERIALS OF CONSTRUCTION

3.1 Corrosion protection

The crane beam and end carriages shall be zinc-sprayed and sealed in accordance with the below systems. Smaller items, such as cable brackets and protective covers, shall be hot-dip galvanized accordingly.

System	Details	Item
System C/2	Zinc sprayed	Crane beam
System – hot Dipped Galvanised	HDG	Smaller items

Where the Tenderer prefers to offer corrosion protection systems other than those specified, these may be offered as an alternative with full details of such recommended systems. The Council reserves the right to reject such offers if considered inadequate by the Engineer.

The Contractor shall arrange for the crane to be inspected by the Engineer at the fabricator's premises prior to preparation for corrosion protection.

The crane final colour shall be Golden Yellow, B49.

The inspection of corrosion protection systems shall be done in accordance with the Standard Specification for Corrosion Protection.

3.2 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.
In the alignment of equipment or structures, the use of multiple shims will not be permitted. All shimmed feet shall be neatly grouted to provide corrosion protection.

The full length of the rails shall be grouted in cases in which the rails rest on a concrete ring 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 45º chamfer. The Engineer shall be notified prior to application of the grout.

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 manufacturing instructions.

4. TESTING AND COMMISSIONING

All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Works testing of the individual assembled items of equipment shall be undertaken at the manufacturer's premises to demonstrate the effective operation of the crane.

Before being put into use the crane shall be load tested in position by the Contractor to 1.25 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. The Contractor shall then supply a test certificate once the crane passes the load test.

Performance testing shall be carried over a single 8 hour shift and shall consist of the following:

- Measurement of power absorbed by all motors; and
- The vibration measured at each point does not exceed the level prescribed in ISO 10816.

The equipment will be considered acceptable when:

- The Contractor supplies the Engineer with a certificate from the manufacturer which:
    - Certifies that the crane has been manufactured in accordance with the requirements of the Occupational Health and Safety Act;
    - Specifies the design standards used;
    - States the safe working load and the test load, and;
    - This certificate shall be provided to the Engineer prior to delivery of the crane to Site.
- Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets;
- The equipment meets the duty requirements as defined in this section of the Specification; and
- Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in ISO 10816, as given in the General Specification for the appropriate class of machine.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M20 LIFTING EQUIPMENT

SECTION M20002: CHAIN BLOCKS AND CRAWL BEAMS

TABLE OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20002: CHAIN BLOCKS AND CRAWL BEAMS

1. SCOPE

This specification covers the supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period for chain blocks and crawl beams.

2. DESIGN SPECIFICATION

2.1 Chain blocks

The chain block casing is to be fabricated from cast iron or high strength grade alloy steel with hot dipped galvanised finish and painted to System E/4. The chains are to be high strength alloy steel and hot dipped galvanised for corrosion protection. A slipping clutch, or equivalent, is to be fitted to ensure that it is not possible to overload the chain block. A trolley, along with all ancillary equipment, is to be provided with the chain block for operation on the crawl beam.

The safe working load (SWL) is to be clearly displayed on either side of the casing of the chain block.

2.2 Crawl beams

Crawl beams shall be fastened to hot-dip galvanised steel support structures using hot-dip galvanised fasteners and it shall be noted that high-tensile, hot-dip galvanised fasteners are available in South Africa.

Crawl beams shall be anchored to concrete using grade 316L anchor bolts. The anchor bolts shall, preferably, be through-bolted. If chemical anchor is used, every anchor shall be load-tested prior to installation of the beam. A nickel-based anti-seize compound shall be applied to bolt threads prior to fastening of the nut and galled fasteners shall be removed and replaced.

Stoppers must be fitted to the open end of the crawl beams so the crawl cannot derail.

The permissible allowable payload must be painted onto the beam.

The safe working load (SWL) of the crawl beam is to be clearly displayed.

3. MATERIALS OF CONSTRUCTION

3.1 Corrosion protection

The corrosion protection of the chain blocks are to be as specified by the supplier.

Crawl beams shall be hot-dip galvanised after all fabrication. If the beam is drilled or welded or the zinc coating is damaged by any other fabrication technique, the complete beam shall have the zinc removed by abrasive blasting and it shall be returned to the galvanisers for hot-dip galvanising. Repair using cold-applied zinc products will not be acceptable. Final painting of the crawl beam shall be to System E/4.

4. TESTING AND COMMISSIONING

All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The contractor must cover the cost of any tests that need to be repeated as a result of the equipment not being able to meet the requirements outlined below.

Before being put into use, the crawl beam and chain block shall be load tested by the Contractor to 1.25 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. The Contractor shall then supply a test certificate once the crane passes the load test.

Performance testing shall be carried over a single 8 hour shift and shall consist of the following:

The requirements stated in the Technical Datasheets

The equipment will be considered acceptable when:

The crawl beam and chain block passes the load tests.

The Contractor supplies the Engineer with a certificate from the manufacturer which:

- Certifies that the crane has been manufactured in accordance with the requirements of the Occupational Health and Safety Act;
- Specifies the design standards used;
- States the safe working load and the test load, and;

The equipment meets the duty requirements as defined in this section of the Specification.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier’s recommendations. Maintenance intervals of major and minor services are to be included.

6. PAYMENT AND MEASUREMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

SERIES M20 LIFTING EQUIPMENT

SECTION M20003: DAVITS AND WINCHES

TABLES OF CONTENTS

SERIES M20 LIFTING EQUIPMENT

SECTION M20003: DAVITS AND WINCHES

1. SCOPE

This specification covers the design, supply, delivery, offloading, transport, double handling (if required), storage, erection, installation, commissioning, testing, adjustment, handing over in complete working order and upholding during the Defects Liability Period of davits and winches.

2. DESIGN SPECIFICATIONS

2.1 Davits

Davits shall be column mounted with swivelling booms and designed to suit the application. The arrangement shall permit easy and safe lifting of the load to a convenient height not less than 500 mm clear of ground level or high enough to permit the load to be swung clear of any obstruction through an angle of at least 180o.

The davit shall be designed for a maximum safe working load at least 50 % above the calculated actual load requirements. The maximum stress permitted in any component at the design load shall be the lesser of:

- One quarter the ultimate tensile stress for the material; and
- One half the yield stress or 0,2% proof stress of the material (as applicable).

The contractor's design calculations shall be submitted to the Engineer for inspection before manufacture may proceed.

Where a portable davit is specified, the construction shall be as light as possible while still complying with the above. Shall be collapsible to make it easy to carry, and be easily removed from or remounted on permanent fittings which shall be provided in the various positions where the davit is to be used.

Each davit shall be provided with a winch rigidly fixed to the davit at a convenient height and position. When portable davits are to be used for lifting submerged or otherwise inaccessible equipment the required length of rope shall be provided for each item of equipment, with the bottom end attached to the equipment (load) and, during normal operation, with the upper end detached from the winch, neatly coiled and tied in a convenient position. A protection system shall be provided which will prevent the rope from being dropped and lost when being attached to or detached from the winch.

Guide pulleys to suit the arrangement shall be provided. 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 52o. The pulley sheaves shall have a diameter at the bottom of the groove of not less than 25 times the wire rope diameter. The groove depth shall be twice the rope diameter or greater.

Operating cross bars, locking arrangements, fixing arrangements, etc., shall not represent a hazard to passers by in any way. If necessary, operating levers shall be hinged so that they can be swung out of the way when not in use.

2.2 Winches

Hand cranked winches shall be rated for a safe working load at least 100 % in excess of the calculated load. All gears, clutches, etc., shall be enclosed in a robust cast iron or cast 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 or lowering. In addition, a locking arrangement to lock the position of the load shall be provided.

The force required to operate the winch at its maximum rated load shall not exceed 100 N.

The radius at which the handle operates shall preferably be adjustable. A double handled crank or two opposing cranks shall be provided when necessary to ensure easy operation in all positions possible with the mounting arrangement provided.

3. MATERIALS OF CONSTRUCTION

3.1 Davits

The davit shall be manufactured from mild steel, be hot-dip galvanised and painted to System E/4 when not in use near water but shall be fabricated from 304L or 316L stainless steel when in use near water. All fasteners, pins, shafts, shackles, hooks, etc., shall be of 316L stainless steel. Guide pulleys and shafts shall be made of 316L stainless steel or other approved corrosion resistant material, and use suitable non-metallic bearings which do not need to be lubricated.

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.

3.2 Winches

The wire rope and all attachments shall be of 316 stainless steel with a safety factor of at least 6. The wire rope shall be long enough to reach the lowest required position with at least 3 turns left on the drum. The drum size shall easily store the full rope length. The inside diameter of the drum shall suit the rope diameter in accordance with good engineering practice approved by the wire rope manufacturer.

The maximum safe working load shall be clearly and permanently marked on the winch. The drum support brackets, all exposed fasteners, shafts, handles, pins, etc., shall be 316 stainless steel and the casing shall be hot-dip galvanized or zinc-sprayed (to a thickness of 150 µm) and then painted System E/4.

4. TESTING AND COMMISSIONING

Performance testing will be carried out on the equipment.

The safe working load shall be clearly and permanently marked on the davit jib, winches and shackles. Before being put into use each davit assembly shall be load tested in position by the Contractor to 1.1 times the maximum safe working load and the Contractor shall arrange for this test to be witnessed by the Engineer. All tests are to be witnessed by the Engineer, and contractors must give the Engineer 14 days notice prior to any test. The Contractor shall then supply a test certificate once the davit passes the load test.

The tests will be performed on the equipment over a single 8 hour shift.

During the Defects Liability Period

Checks on all equipment will be conducted for correct operation and functioning at 1 month, 6 months and 12 months after plant take-over.

5. SPARES

A list of the recommended spares and consumables for a maintenance period of three years is to be provided in the technical data sheet. The list of spares is to be according to the equipment supplier's recommendations. Maintenance intervals of major and minor services are to be included.

6. MEASUREMENT AND PAYMENT

6.1 Design and supply

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for design, manufacture, factory testing, supply, delivery and storage on site of the unit.

6.2 Installation and commissioning

The unit of measurement shall be for the unit supplied including all ancillary equipment and accessories as specified.

The tendered rates shall include for full compensation for the installation, fixing of corrosion protection where needed and commissioning of the unit supplied, and for all other costs and actions that are necessary for obtaining an efficient and complete working system.

Payment will only be transferred once the engineer has received full Operation and Maintenance Manuals along with the relevant plant drawings.

MECHANICAL PROCESS CONTROL PHILOSOPHY

TABLE OF CONTENTS

INTRODUCTION

1.1. SCOPE OF THE PROCESS CONTROL PHILOSOPHY

This document covers the requirements for data monitoring and process control of the Libode Wastewater Treatment Works.

1.2. PURPOSE

The purpose of this document is to give the Oliver Tambo District Municipality's requirements regarding operational control of the works, and data collection and communication.

It is the municipal requirement that the SCADA system should have capacity to collect and interpret data from all pump stations at the treatment works and the sewage pumpstation outside of the treatment works. The proposed data collection and communication system infrastructure should be capable of taking advantages provided by advanced communication technologies currently available on the market.

1.3. GENERAL OPERATIONAL CONTROL PHILOSOPHY

It is intended that the operation of the works is not automated except for the chlorine dosing system. The control philosophy shall monitor for emergency conditions that may arise during normal operation of the works and communicate these conditions to the Operator in real time. An alarm system shall be built into the operation of the works whenever malfunctioning of electromechanical equipment is detected, or when critical site measurable and controllable operational parameters exceed the desired limits.

1. <u>REQUIRED DATA MONITORING</u>

This specification lists the data monitoring and communication requirements on the works and lists the measurement, communication, interpretation, and display of information required for optimal plant operation and maintenance purposes. Including flow measurements at various plant positions, water level detection on critical areas, on-line physical and analysis of wastewater characteristics to ensure effective plant control and optimal treatment, measurement and control of automated chemical dosing, as well as general monitoring of operational status of all electromechanical infrastructure.

2.1 INLET WORKS

2.1.1 <u>Flow Measurement</u>

Instantaneous flow measurements at the Inlet Works should be provided and communicated to the SCADA system for real time display of flows to the plant Operator.

The operation of the screens will be manual.

2.1.2 Monitoring of Operational Status of Electromechanical Equipment

The SCADA system shall monitor the operational status of all inlets works electromechanical equipment. This includes monitoring and display of operational status of inlet works flow meter

2.2 PRIMARY SETTLING TANKS

No data will be recorded for process control

2.3 INTERMEDIATE SETTLING TANKS

No data will be recorded for process control

2.4 BIOFILTER TANKS

No data will be recorded for process control.

2.5 HUMUS TANKS

2.3.1 Physical Analysis Probes at Clarifiers

Sludge Blanket Probes

Sludge blanket level detectors to be installed in all Humus tanks to detect rise of sludge blanket in each tank. The system should be designed to communicate this information to the Operator via the SCADA system. An alarm indicator should also be triggered, which should be deactivated through acknowledgement by the Operator.

Suspended Solids

Probes to measure suspended solids overflowing with the effluent from the clarifiers. These shall be linked to the SCADA system, and should trigger an alarm when the suspended solids are above the standard limit of 25 mg/l.

2.3.2 Chemical Analysis Probes

On-line measurement of the nitrate and phosphate concentration in the final clarifiers. A reduction of nitrate in the humus tanks will be used to monitor whether de-nitrification is occurring. Measurement of the nitrate concentration in the tanks will be used to adjust the recycle rate.

2.6 CHLORINATION FACILITY

2.4.1 Physical Analysis Probes

Chlorination Rate

An intelligent system shall be implemented at the Chlorination Room, such that chlorination rate is commensurate with the flow. This shall be effected by installation of a flow meter prior to chlorination, and linking the flow to the required dosing rate. The system shall be designed to automatically adjust the dosing rate to match the flow.

Suspended Solids

A sensor for measurement of suspended solids at the end of the chlorine contact tank to ensure that the desired limit is not exceeded. Data from the probe should be linked to an indicator in the SCADA system and should trigger an alarm to the Operator.

The system shall also compare the suspended solids at the chlorine contact tank with that in the clarifiers. Significantly high suspended solids at the final effluent compared to the effluent from the Clarifiers would indicate abnormal conditions, which could be as a result of significant accumulation of solids at the Chlorine Contact Tank, or high growth of scum. This should be the trigger for the required maintenance to the Chlorine Contact Tank.

2.4.2 Chemical Analysis Probes

A Probe for monitoring of residual chlorine shall be installed in the final effluent leaving the chlorine contact tank. This reading shall be communicated to the Operator via the SCADA system. The SCADA system shall allow the Operator to overwrite the automatic dosing system, and remotely set a chlorine dosing rate to the desired value.

2.7 SUPERNATANT RETURN PUMP STATIONS

In addition to normal operational water level detection overflow conditions on all pump stations shall be monitored and linked to an indicator in the SCADA system. A siren alarm system shall also be triggered, which will be deactivated on acknowledgement from the Operator.

The supernatant and recycle pump stations shall include flow measurement linked to the SCADA system.

The pumps shall also be fitted with a timer switch to control the number of starts per hour.

A pressure switch shall also be supplied for pump dry-run protection. A manual override shall also be supplied

2.8 SEWAGE PUMP STATION

One duty and one standby pump shall be installed with all its associated pipework. The pumps will be controlled by a high/low ultrasonic level sensor with float switch backup. The flow measurement of the pumpstation is linked to the SCADA system at the WWTW

EMERGENCY MEASURES

The plant will be equipped with bypass facilities in the case of a complete power failure. The emergency facilities consist of a flow diversion from the inlet works (post-screening) to a surge/detention pond linked to the maturation pond and reed bed system. This pond will have a surge capacity of 1 day at the planning horizon. Pumping will be provided to return this flow to the recirculation pump station or inlet works.

2.9 SUMMARY OF REQUIRED PROCESS AND ELECTROMECHANICAL MONITORING

Data collection, communication, interpretation, and presentation in the SCADA system shall satisfy the process control and electromechanical monitoring schedule summarized in Tables 2 and 3 below.

Description	**Operational and Process Control Monitoring**	**Data Monitoring and Display to SCADA System**	**Alarm Trigger Condition**	**Alarm Indicator**		**Required Operator Intervention from SCADA System**
				Screen	**Siren**	
Inlet Works	Influent Flow Measurement	Real time measurement of influent flow	Flow 20% more than the average flow to the works	x	-	Nil
Biological Filters	Nil	Nil	Nil	-	-	Nil
Primary Settling Tanks	Nil	Nil	Nil	-	-	Nil
Intermediate Settling Tanks	Nil	Nil	Nil	-	-	Nil
Humus Tanks	Nil	Nil	Nil	-	-	Nil
Disinfection	Chlorination rate	Monitoring of chlorination rate relative to the effluent flow	Zero chlorination rate	x	x	Manual overwrite option to chlorinate to desired value
	Effluent Suspended Solids	Probes and communication of SS concentration to the SCADA system	Suspended solids increasing above 25 mg/l	x	-	-
	Residual Chlorine in Effluent	Probes and communication of residual chlorine concentration in the effluent	No residual chlorine on effluent	x	-	Manual overwrite of automatic chlorination to desired
Recycle Pump Station	Sump Overflow	Overflow conditions to be detected and communicated to the SCADA system	Water level rising above set overflow level	x	x	Increase or decrease of pumping rate from the SCADA system
Sludge Lagoons	Sump Overflow	Overflow conditions to be detected and communicated to the SCADA system	Water level rising above set overflow level	x	x	Increase or decrease of pumping rate from the SCADA system
Sewage Pump Station	Flow Measurement	Real time measurement of influent flow	Nil	x	-	Nil

***Table 2:* Summary of Required Process Control Monitoring**

2.6.1 Summary of Required Electromechanical Equipment Monitoring

Table 3 summarizes alarm conditions that shall be triggered by the SCADA system when malfunctioning or failure of any of the electromechanical equipment has been detected.

Description	**Electromechanical Monitoring**	**Alarm Indicator**	
		Screen	**Siren**
Inlet Works	Flow meter	x	-
Biological Filter	-	-	-
Primary Settling Tanks	-	-	-
Intermediate Settling Tanks	-	-	-
Humus Tanks	Chemical and Physical Probes	x	-
Disinfection	Chlorine Dosing Pumps	x	x
	Recycle Pumps	x	x
	Effluent Flow Meter	x	-
	Chemical and Physical Probes	x	-
Sludge Drying Beds	Supernatant Recycle Pumps	x	-

Table 3: Summary of Required Electromechanical Equipment Monitoring

PART C: ELECTRICAL WORKS

PS2: STANDARD SPECIFICATION FOR ELECTRICAL WORK

CONTENTS

GENERAL REQUIREMENTS:

E200.1 SCOPE OF WORK

1.1 The scope of work for the electrical portion of the Works is set out in the Project Specification*** and associated drawings and schedules.

1.2 This Standard Specification shall be read in conjunction with the Project Specification where referenced in the Project Specification***. In the event of conflict the Project Specification shall take precedence over this Standard Specification.

E200.2 ELECTRICITY SUPPLY

2.1 The electricity supply will be made available by the Supply Authority as described in the Project Specification, and the Contractor shall ensure that the completed Works complies with the Supply Authority's requirements regarding voltage, current and quality of supply limits, and with any other requirements which may be imposed by the Supply Authority.

2.2 The electrical characteristics of the electricity supply will be as specified in the Project Specification***.

2.3 Where specified in the Project Specification***, the Contractor shall make application for the electricity supply, liaise with the Supply Authority to plan and coordinate work, liaise with the Supply Authority regarding protection settings, and attend technical meetings and provide inputs for the planning of switching operations.

E200.3 GENERAL

3.1 Standard Specification

This Standard Specification specifies the detail requirements for plant, and the standard of workmanship and quality of materials, for the electrical portion of the Works as varied by the Project Specification.

Where this Standard Specification and the Project Specification refer to "relevant codes and specifications", it shall be taken to refer to those listed in the table contained in Clause E200.5 and the normative references listed in SANS 10142, as applicable.

The use of the triple asterisk "***" after the words “Project Specification” is intended as a prompt for the Specifier only, and does not infer an intention to cross-referencing.

3.2 Definitions

3.2.1 *"Extra low voltage"* shall mean voltages of 50 V or less.

3.2.2 *"Low voltage"* shall mean voltages not exceeding 1 000 V.

3.2.3 *"Medium voltage"* shall mean voltages exceeding 1 000 V.

3.2.4 *"Supply"* shall mean manufacture, procure, store off site as necessary, deliver to site, and off-load, position, stack and store on site as necessary.

3.2.5 *"Install"* shall mean set out, erect, mount, align, fix, connect, adjust, test and commission and hand over in proper working order.

3.2.6 *"Provide"* shall mean supply and install.

3.2.7 *"Installation"* shall mean the electrical installation covered by this document.

3.2.8 *"Approved"* shall mean acceptable to the Employer in the sole opinion of the Engineer.

E200.4 COMPLIANCE WITH REGULATIONS AND STANDARDS

4.1 The electrical installation shall comply with the latest revisions and amendments of the following:

4.1.1 The South African Bureau of Standards Code of Practice for the Wiring of Premises, SANS 10142, referred to herein as the "Wiring Code".

4.1.2 The Occupational Health and Safety Act and Regulations (Act No 85 of 1993) in its entirety.

4.1.3 The Municipal By-laws and Regulations and any regulations of the electrical supply authority.

4.1.4 The Local Fire Office regulations.

4.1.5 Regulations of Telkom.

4.1.6 The relevant codes and specifications as defined under Clause E200.3.

4.1.7 The regulations of the local gas supplier where applicable.

4.1.8 The standard regulations of any Government Department or other statutory body where applicable.

4.2 No claims for extra costs arising from failure of the Contractor to comply with any of the regulations and standards listed above will be considered.

4.3 Where conflict appears to exist between any of the regulations and standards listed above and the Specification, such conflict shall be referred to the Engineer in writing for his ruling.

4.4 Immediately after award of the Contract, and at any time thereafter as may be necessary, the Contractor shall notify all relevant authorities, pay fees and take any other steps which may be required or prescribed to execute the Works.

The Contractor shall copy related correspondence to the Engineer who shall be kept informed at all times. This shall not, however, release the Contractor of his responsibilities.

E200.5 STANDARD SPECIFICATIONS

All the equipment and materials shall conform to the relevant SANS, NRS, or IEC Specifications and the latest revisions thereof, where applicable. For equipment and materials not covered by the following table, reference shall be made to the list of normative references in SANS 10142.

	DESCRIPTION	SANS	IEC	NRS
1.	**SWITCHGEAR AND CONTROL GEAR**			
1.1	HV switches for rated voltages above 1 kV and less than 52 kV	60265-1		

	DESCRIPTION	SANS	IEC	NRS
1.2	A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	62271-200		
1.3	HV a.c. switch-fuse combinations	62271-105		
1.4	HV a.c. contactors and contactor-based motor starters	60470		
1.5	Common specifications for HV switchgear and controlgear standards	60694		
1.6	A.C. insulation-enclosed switchgear and control-gear for rated voltages above 1 kV and up to and including 52 kV	62271-201		
1.7	Metal-enclosed switchgear for rated a.c. voltages above 11 kV and up to and including 36 kV	1885		
1.8	HV a.c. circuit breakers	62271-100		
1.9	Metal-clad switchgear for rated voltages above 11 kV and up to and including 24 kV - Part 2 : Standardized panels			003-2
1.10	Moulded-case circuit breakers	156		
1.11	LV switchgear and controlgear assemblies - Part 1 : Type-tested and partially type-tested assemblies above 10 kA	1973-1 60439-1		
1.12	LV switchgear and controlgear assemblies - Part 2 : Busbar trunking systems	60439-2		
1.13	LV switchgear and controlgear assemblies – Part 3 : Type-tested and partially type-tested assemblies up to and including 10 kA	1973-3		
1.14	LV switchgear and controlgear assemblies – Part 8 : Safety of MTAs above 10 kA	1973-8		
1.15	LV switchgear and controlgear assemblies - Part 5 : Particular requirements for assemblies intended to be installed outdoors in public places - cable distribution cabinets	60439-5		
1.16	LV switchgear and controlgear - Part 2 : Circuit breakers	60947-2		
1.17	LV switchgear and controlgear - Part 3 : Switches, disconnectors, switch-disconnectors and fuse-combination units	60947-3		
1.18	LV switchgear and controlgear -			
	Part 4 - 1 : Contactors and motor starters (electro-mechanical) Part 4 - 2 : Contactors and motor starters (semi-conductor)	60947-4-1 60947-4-2		
	Part 5-1 : Electromechanical control circuit devices	60947-5-1		
	Part 5 - 2 : Proximity switches	60947-5-2		
	Part 5 - 5 : Electrical emergency stop device with mechanical latching function	60947-5-5		
	Part 6 - 1 : Automatic transfer switching equipment	60947-6-1		

	DESCRIPTION	SANS	IEC	NRS
1.19	Earth-leakage protection units - Part 1 : Fixed earth-leakage protection circuit breakers	767-1		
1.20	RCCBs without integral overcurrent protection for household and similar use - Part 1 : General rules	61008-1		
1.21	Switches for appliances - Part 1 : General requirements	61058-1		
1.22	AC disconnectors and earthing switches above 1 kV	62771-102		
1.23	Busbars	1195		
1.24	Metal-enclosed ring main units for ac voltages 1 kV to 24 kV	1874		
2.	**TRANSFORMERS AND MINISUBS**			
2.1	Power transformers	60076		
2.2	Dry-type power transformers		60726	
2.3	Distribution transformers	780		
2.4	Semiconductor converters - Part 1 - 3 : General requirements and line commutated convertors - Transformers and reactors	60146-1-3		
2.5	Convertor transformers - Part 1 : Transformers for industrial applications	61378-1		
2.6	Safety of power transformers, power supply units and similar - Part 2 - 4 : Particular requirements for isolating transformers in general use	61558-2-4		
	Part 2 - 6 : Particular requirements for safety isolating transformers in general use	61558-2-6		
	Part 2 - 15 : Particular requirements for isolating transformers for the supply of medical locations	61558-2-15		
2.7	Miniature substations	1029		
3.	**CABLES**			
3.1	The selection, handling and installation of electric power cables of rating not exceeding 33 kV (Parts 1 to 14)	10198		
3.2	Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3 kV to 33 kV	97		
3.3	XLPE-insulated cables for voltages from 6,6 kV to 33 kV	1339		
3.4	Paper-insulated metal-sheathed cables for voltages up to 18/30 kV			
	- Part 1 : Test on cables and their accessories		6055-1	
	- Part 2 : General construction requirements		6055-2	

	DESCRIPTION	SANS	IEC	NRS
3.5	Electric cables with extruded solid dielectric insulation for fixed installations (300 / 500 V to 1900 / 3300 V)	1507		
3.6	Flexible electric cables for use in mines			
	- Part 1 : LV (640/1100 V and 1900 / 3300 V)	1520-1		
	- Part 2 : HV (6,6 kV to 33 kV)	1520-2		
3.7	Flexible cords and cables	1574		
3.8	Materials of insulated electric cables and flexible chords (Parts 1 to 7)	1411		
3.9	Mechanical cable glands	1213		
3.10	Single core arc welding cable	1576		
3.11	Lugs and ferrules for insulated electric cables - Part 1 : copper conductors	1803-1		
3.12	Power cables with extruded insulation and their accessories from 1 kV to 30 kV - Part 4 : Test requirements on accessories	60502-4		
3.13	Accessories for MV power cables			053
4.	**CURRENT AND VOLTAGE TRANSFORMERS**			
4.1	Instrument transformers			
	- Part 1 : Current transformers	60044-1		
	- Part 2 : Inductive voltage transformers	60044-2		
	- Part 3 : Combined transformers	60044-3		
	- Part 5 : Capacitive voltage transformers	60044-5		
5.	**EARTHING AND LIGHTNING / SURGE PROTECTION**			
5.1	Earth rods and couplers	1063		
5.2	Design and installation of an earth electrode	10199		
5.3	Neutral earthing in MV industrial power systems	10200		
5.4	Protection of structures against lightning	10313		
5.5	Protection against lightning			
	- Part 1 : General principles	62305-1		
	- Part 2 : Risk management	62305-2		
	- Part 3 : Physical damage to structures and life hazard	62305-3		

	DESCRIPTION	SANS	IEC	NRS
	- Part 4 : Electrical and electronic systems within structures	62305-4		
5.6	Surge protective devices connected to LV power distribution systems - Part 1 : Performance requirements and testing methods	61643-1		
5.7	Surge arrestors - Part 1 : Non-linear resistor type gapped surge arrestors for a.c. systems	60099-1		
5.8	Surge arrestors - Part 4 : Metal-oxide surge arrestors without gaps for a.c. systems	60099-4		
6.	**METERS, INSTRUMENTS AND RELAYS**			
6.1	Meter cabinets	60439-5		
6.2	Electrical instruments and meters		60051	
6.3	A.C. electromechanical watt-hour meters	62052-11		
6.4	Electrical relays - Part 3 : Single input energizing quantity measuring relays with dependent or independent time		60255-3	
6.5	Electrical relays - Part 20 : Protection systems		60255-6	
6.6	Watt-hour meters - A.C. electronic meters for active energy	1799		
6.7	Electricity metering equipment – static meters	62053-21 to 23		
7.	**CAPACITORS**			
7.1	Shunt capacitors for a.c. power systems having a rated voltage above 1000 V			
	- Part 1 : General - Performance, testing and rating - safety requirements - Guide for installation and operation		60871-1	
	- Part 2 : Endurance testing		60871-2	
	- Part 3 : Protection of shunt capacitors and shunt capacitor banks		60871-3	
	- Part 4 : Internal fuses		60871-4	
7.2	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V			
	- Part 1 : General - Performance, testing and rating - Safety requirements - Guide for installation and operation		60831-1	

E200.6 BUILDER'S WORK

6.1 Building and Casting-In

The Contractor shall be responsible for placing in position all wireways, conduits, conduit boxes, etc., for the building contractor to build in/cast in, provide attendance to the building contractor during building-in/casting-in, and ensure firm fixings acceptable to the building contractor and accurate positioning.

6.2 Chasing

6.2.1 The Contractor shall chase only where it is impossible to build in/cast in.

6.2.2 No face-brick or finished surface may be chased without the permission of the Engineer and the building contractor.

6.2.3 No structural concrete may be chased without the permission of the Engineer and the building contractor.

6.2.4 The building contractor will make good all chases and openings in building work.

6.2.5 The Contractor will be held responsible for any damage caused by him to the building work or any other service.

6.3 Ducts, Sleeves and Openings

6.3.1 The Contractor shall provide attendance to the building contractor with the installation of ducts, sleeves, manholes, openings and any other building work associated with the electrical installation to ensure correct and accurate positioning.

6.3.2 No openings or cuts may be made in structural concrete without prior permission of the building contractor and Engineer.

6.3.3 The Contractor shall in good time provide to the building contractor dimensions, details and positional information for frames, pipe sleeves, recesses, access ways, servitudes, apertures and openings for equipment installed under this Contract.

E200.7 DRAWINGS, MANUALS, LITERATURE, TUITION, SPARES AND TOOLS

7.1 The Engineer's drawings covering the various sections of the installation are listed in the schedule of drawings. The working drawings of the Contract shall, however, consist of the following, where applicable:

7.1.1 The Engineer's drawings;
7.1.2 The Architect's drawings;
7.1.3 The Structural Engineer's drawings;
7.1.4 The Engineer's drawings of the other disciplines, as applicable.
7.1.5 The drawings of other services installations that are relevant for co-ordination and installation.
7.1.6 The installation drawings of other Contractors and Subcontractors where applicable.

7.2 Unless otherwise specified, three sets of the Engineer's drawings will be issued to the Contractor for construction purposes. Any further copies may be purchased from the Engineer.

7.3 The Contractor shall submit four copies (or as required in the Project Specification***) of shop drawings to the Engineer for examination and to demonstrate compliance with the Contract. Shop drawings shall include drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor, Manufacturer, Supplier or Distributor and which illustrate some portion of the work.

The Engineer's examination of shop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of this Contract unless the Contractor has informed the Engineer in writing of such deviations at the time of submission of shop drawings or samples and the Engineer has given written approval for the specific deviation, nor shall the Engineer's examination relieve the Contractor of responsibility for errors or omissions in the shop drawings or samples or for responsibility for erection or installation fit.

7.4 The Contractor shall submit to the Engineer four copies (or as required in the Project Specification***) of marked-up structural drawings, or other drawings, showing changes and/or additional requirements to be made in the structure in order to accommodate equipment installed under this Contract.

7.5 The Contractor will not be allowed to rely on the Engineer for as-installed information which he may have compiled, to produce record drawings.

7.6 Drawings to be entitled “Record” shall bear the signature of the Contractor, or his authorised representative, and the date.

7.7 The Contractor shall obtain from the Engineer, if available, a CD containing the Engineers' drawings, which have been drawn on a PC-based CAD system for the preparation of record drawings to be provided by the Contractor. One set of paper prints of the record drawings shall be provided for verification by the Engineer. A CD containing the record drawings shall be provided upon completion of the contract. Otherwise the Engineer will issue a set of Engineer's drawings to the Contractor at completion of the installation. The Contractor shall mark these drawing to indicate the record of the installation.

7.8 A set of final layout and schematic record drawings shall be provided in a purpose made holder inside the door of each distribution board and motor control centre, or where no doors are fitted, to the front plate of the cabinet. The frame shall be adequately sized to receive the equivalent of two A1 size drawings folded to a nominal size of A4.

For MV switchboards, MCCs and main LV distribution boards the Contractor shall provide laminated as-built drawings of single-line diagrams in aluminium/wooden frames fixed to the wall of the room housing the switchboards/MCCs.

7.9 The Contractor shall submit to the Engineer four (or quantity as specified in the Project Specification***) manuals bound between hard covers including the following :-

1) Dimensioned drawings of the layout of the equipment and systems.

2) Wiring diagrams cross referred to the drawings described above, and to the Engineer's layout drawings and single-line diagrams.

3) All Test Certificates for tests done at the factories and on the site.

4) System and equipment descriptions.

5) Operating instructions.

6) Maintenance, adjustment and calibration instructions with preventive maintenance schedule and fault-finding procedures.

7) Spare parts list with names and address of component suppliers and price list of all components and a list of recommended spare components to be kept in stock.

The Contractor shall submit preliminary copies of the manual to the Engineer for scrutiny.

7.10 The Contractor shall provide thorough tuition of the Employer's staff in the operating and maintenance of the plant forming part of the Works.

7.11 When specified in the Project Specification*** the Contractor shall allow in his price for photographs to be taken with a digital camera on monthly basis, for the duration of the Contract, of all the areas and plant forming part of the Works. The photographs shall be properly dated with comments e.g. access to substation not possible etc. A CD with the photographs shall be handed each month to the Engineer at the site meeting. These photographs may be used for the evaluation of claims.

7.12 The Contractor shall provide all tools required for operating and/or maintaining the Works as specified in the applicable Standard Specification and the Project Specification***.

E200.8 INSPECTION, TESTS AND COMMISSIONING

8.1 On completion of erection and installation on site the Contractor shall perform all the tests that may be required by the Engineer in his presence to ensure that the Works are ready for handing over and putting into regular use.

8.2 Near completion, inspect and test the services installation in accordance with the Wiring Code, the Regulations of the Supplier of Electricity and the Occupational Health and Safety Act 85/1993. Record test results on printed test sheets and submit to the Engineer.

8.3 Testing of the electrical installation shall be in accordance with the Project Specification, but shall include the following:

- Ensure correct polarity, phase rotation and balance load between the phases. Verify polarity and phase identification.
- Continuity and resistance of earth conductor including all bonding conductors.
- Continuity of ring circuit.
- Earth electrode resistance.
- Insulating resistance.
- Earth fault loop impedance test.
- Operation of earth leakage protection devices and circuit breakers.

8.4 After inspection and testing, timeously arrange for any inspection and test by the Supplier of Electricity if required, and assist as necessary the Inspector of the Supplier of Electricity by providing access, tools, instruments and attendance.

8.5 Replace any portion of the electrical installation that does not comply with the Wiring Code or the Specification. Such replacement shall be done at the Contractor's expense.

8.6 Submit a "Certificate of Compliance by an accredited person" Annexure 1 in terms of the Occupational Health and Safety Act 85/1993, Electrical Installation Regulation 1992, to the Employer and forward a copy to the Engineer.

8.7 Carry out additional special tests as required by the Engineer and provide the required test equipment.

8.8 Timeously advise the Engineer of all inspections and tests as the Engineer reserves the right to witness such inspections and tests.

8.9 Provide access, tools, instruments and attendance, to assist the Engineer who may perform verification tests at any time.

8.10 The Engineer shall have the power at any time to examine any part of the Works or materials intended for use in or on the Works either on site, or at the place of manufacture or storage.

8.11 On completion of the works, the Contractor shall submit four indexed volumes of all test certificates to the Engineer for tests done at factories and on site. (To be included in the manuals).

8.12 The Contractor shall be responsible to calculate all relay settings. The settings shall be submitted to the Engineer for approval at least two weeks before the commissioning of the works commences. The settings shall be substantiated by calculation sheets and graphs where applicable.

8.13 The Contractor shall check that all protection relays and overload devices are properly set to protect equipment such as motors, cables and capacitors etc., before the system is energised or any motors are switched on. Where overload devices are overrated or the ranges of relays insufficient to protect equipment, the Engineer shall be informed and the equipment shall not be energised.

8.14 Inspections, Tests and Commissioning with Reference to Material and Equipment

8.14.1 FACTORY TESTS AND INSPECTIONS

The manufacturer shall perform all routine tests in the factory as described by SANS, IEC and/or BSS as well as the manufacturers own standard routine tests on all materials, equipment and auxiliary equipment. Type tests shall be performed as described in the relevant equipment specifications.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard tests that may be required by the Engineer.

The Engineer shall indicate which tests shall be witnessed by a representative of the Employer and the Engineer.

The Contractor shall submit four copies of the test certificates with the test results of all the tests performed to the Engineer not later than the delivery date of the equipment.

8.14.2 SITE TESTS

On completion of erection and installation on site the Contractor shall perform all the tests that may be required to ensure that the Works are ready for handing over and putting into regular use.

Contractors shall provide their own test equipment which shall be of accepted standards.

The Contractor shall submit a list of tests and inspections to be performed on the equipment for approval.

The Contractor shall perform any additional standard test that may be required by the Engineer.

All the tests shall be witnessed by a representative of the Employer and the Engineer.

Four copies of site test certificates shall be submitted to the Engineer within 7 days after completion of each test.

8.14.3 ARRANGEMENTS FOR WITNESSING TESTS

The Contractor shall make arrangements with the Engineer for tests to be witnessed.

Timeous (at least two weeks, or as specified in the Project Specification***) notice shall be given to avoid undue delays in the completion of tests.

Arrangements for tests on site shall be made only after the Contractor has pre-commissioned the equipment and satisfied himself that it is in running order.

E200.9 FIRE EXTINGUISHERS. FIRST AID KITS DANGER AND INSTRUCTION SIGNS FOR SUBSTATIONS

9.1 Fire Extinguishers

9.1.1 Unless otherwise specified, 5 kg type fire extinguishers or nearest standard sizes offered by manufacturers, shall be supplied for substation building.

9.1.2 Fire extinguishers shall be of the CO_2 type or of a type approved for the fighting of fires where electrical apparatus and oil fires are involved.

9.1.3 Unless otherwise specified, fire extinguishers shall be provided as follows:

1) Medium voltage switchrooms: one extinguisher per 30 m^2 of floor area.
2) Low voltage rooms: one per room.
3) Transformer rooms: one per transformer.

9.1.4 Fire extinguishers shall be mounted on suitable wall mounted brackets.

9.1.5 Fire extinguishers shall be installed next to exit doors wherever possible.

9.2 First Aid Kits

9.2.1 Industrial type first aid kits as supplied by St John Ambulance or the South African First Aid Society, shall be provided for substation buildings.

9.2.2 The first aid kit shall be housed in a suitable metal box with internal trays and a metal lid.

9.2.3 The first aid kit shall be mounted on a suitable wall mounted shelf next to the substation main exit door.

9.2.4 One first aid kit shall be provided for every substation building.

9.3 Danger Signs and Notices

9.3.1 All outside doors of all substations and all substation yard entrance gates shall be provided with a sign showing a lightning strike.

9.3.2 Suitable notices prohibiting unauthorised persons from entering premises shall be provided on all doors and gates of substation buildings and yards.

9.3.3 The following notices shall be provided and mounted against walls inside substation buildings:

1) A notice prohibiting unauthorised persons from handling or interfering with electrical apparatus.
2) A notice containing directions as to resuscitation of persons suffering from the effects of electrical shock.

3) A notice containing directions as to procedure in case of fire.

9.3.4 One set of notices called for above shall be provided and installed for each substation building

9.3.5. The notices shall be displayed at a prominent position inside the building.

9.3.6 The notices shall be made from suitable plastic with engraved lettering.

E200.10 NAMEBOARDS

When specified in the project specification*** name-boards shall be supplied, delivered and erected by the Contractor. The Engineer will indicate the dimensions of the nameboards to the Contractor.
The name-boards shall be constructed of timber with masonite front, all of sufficient robustness and rigidity to the satisfaction of the Engineer, and shall be manufactured and finished as set out on the drawing. The Contractor can purchase the CESA emblem from Consulting Engineers South Africa.

E201 MATERIALS

1. Materials and equipment used in this Contract shall, where possible, be of South African manufacture and shall comply with this specification and relevant SANS, BSI and IEC Specifications and shall be approved and installed to the satisfaction of the Engineer.

2. The Contractor shall submit samples of all materials and equipment for examination by the Engineer before installation, unless prior consent to the contrary has been obtained in writing from the Engineer. Such samples will be held for comparison with equipment and materials installed and will be released on satisfactory completion of the Contract. Similar equipment and material shall be of the same manufacture and interchangeable and be standard products from established manufacturers.

3. Where a certain manufacturer's material or equipment is specified, listed in the Schedules or noted on the drawings, such materials or equipment shall be provided as specified, except where an alternative is allowed.

4. Where certain products of a specified manufacturer are unobtainable, substitutes may be offered, but shall only be supplied after written consent by the Engineer.

5. Where the words 'or approved equivalent' follow a manufacturer's name and catalogue reference, the materials shall be of the specified manufacture and reference, or, if the Contractor wishes to use a substitute the onus shall be on the Contractor to prove such substitute is equivalent to the specified manufacture and reference. The decision as to the acceptance of such substitute shall rest solely with the Engineer, whose decision shall be final. If the Engineer instructs the Contractor to install the materials of the specified manufacture and reference, then no alteration to the Contract value or rates will be allowed.

6. Where a detailed specification for material or equipment is not provided, the Contractor shall select such material or equipment to comply with normal practice and to suit the particular application in all respects.

E202 FINISHING AND PAINTING OF MATERIALS AND EQUIPMENT

1. The Contractor shall select materials and their finishing to avoid corrosion.

Exterior applications within 50 km of the coast shall be deemed corrosive.

Aluminium shall be anodized to SANS 999 - 1986 Grade A for exterior and Grade B for interior applications.

2. Unless otherwise specified, finish steel as follows:

Interior Applications and Non-corrosive Exterior Applications

Galvanize to SANS 121 or paint by :

- Preparing surface
- Priming with zinc chromate of dry film thickness of 25 microns (minimum)
- Applying two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

Exterior Corrosive Applications

- Hot dip galvanize to SANS 121
- Prepare surface and prime with calcium plumbate of dry film thickness of 25 microns (minimum);
- Apply undercoat to SANS 681 Type 2
- Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

NOTE: Measure dry film thickness to SANS Standard Test Method 140 or 141.

Hot-dip galvanize steel after all fabrication. Reinstate damaged hot-dip galvanizing with hot zinc spraying. Reinstate damaged electro-galvanizing with two coats of zinc-rich paint.

Any unpainted steel shall be chromium-plated or similarly plated to approval.

3. Where required paint aluminium surfaces as follows :

- Thoroughly clean.

- Apply a self-etch primer Plascon Hi-Sheen or approved alternative.
- Apply two final coats of high gloss enamel paint to SANS 630 Grade 1, each coat of dry film thickness of 25 microns (minimum).

E203 FIXING OF MATERIALS

1. Fix surface-mounted luminaires, metal draw boxes, switched socket outlets and disconnectors, metal channels, wiring troughs or trays, cable trays, saddles, conduiting and accessories, brackets, braces, trunking and all other surface-mounted material and equipment as described below :

    1.1 Concrete (in situ) - expanding cast-in, or gun-bolted, metal screw-fasteners.

    1.2 Precast concrete - only with permission of the Engineer.

    1.3 Brickwork - expanding, or built-in metal screw fasteners.

    1.4 Ash brick - "J bolts" or approved alternative.

    1.5 Steelwork - drilled, gun-bolted, or tapped and screwed metal screw fasteners; or steel gun-bolt nails or, where permitted by the Engineer, welding.

    1.6 Woodwork - woodscrews, not nails.

    1.7 Hollow tiles - spring toggles of not less than 6 mm diameter, but only with permission from the Engineer.

    1.8 Exposed to weather - solid brass or stainless steel screw-fasteners.

2. Where any equipment or material is to be mounted on the surface of ceilings, false ceilings, dry wall partitions, or other specialized surfaces, mount such equipment or material only as specified by the Engineer or as approved by the Engineer in writing.

3. Where sizes of fasteners etc. are not specified, submit samples and proposals to the Engineer for approval.

4. Do not gun-bolt into ash bricks, brickwork or precast concrete, except as permitted by the Engineer in writing.

5. The Contractor will be held responsible for any damage to Builder's work due to unauthorized inadmissible gun-bolting.

6. Do not use plastic plugs, wooden plugs or any other soft substance plugs.

    "Fischer", or approved alternative hard nylon plugs of not less than 6 mm diameter may be used for fixing light materials to suitable surfaces.

    Plugs shall not be installed in mortar joints between bricks.

7. Provide suitable washers under screw heads and nuts.

8. Install materials in accordance with manufacturer's instructions and recommendations in all respects including type, size and spacing of fixings.

E204 ENCLOSURES FOR DISTRIBUTION BOARDS, MOTOR CONTROL CENTRES AND OTHER ELECTRICAL SERVICES PANELS

1. GENERAL

1.1 This specification covers sheet metal enclosures for distribution boards (DBs), motor control centres (MCCs) and panels for other electrical services such as telephone, fire detection and intruder alarm systems.

1.2 This specification shall be read in conjunction with the following standard specifications to provide a complete specification for LV DBs and MCCs:

- E205 : LV switchgear and controlgear
- E206 : Busbars
- E207 : Current transformers
- E208 : LV motor protection
- E209 : Wiring in DBs, MCCs and panels
- E210 : Wiring- and cable terminations
- E211 : Glands and gland plates
- E213 : Switchboard accessories
- E214 : Nameplates and labels
- E215 : Metering and indication equipment

1.3 For MV MCCs, the following specifications shall also be read in conjunction with this specification and those listed under Clause 1.2:

- E225 : MV disconnectors and earth switches
- E226 : MV contactors
- E227 : Voltage transformers
- E228 : MV protection and relays

1.4 The Project Specification*** sets out which DBs, MCCs and panels shall be provided under the contract.

1.5 Unless otherwise stated in the Project Specification***, MCCs and floor-standing distribution boards shall be Form 4a to SANS 60439.

1.6 Enclosures shall be completely vermin-proof and unless otherwise stated in the Project Specification*** indoor enclosures shall have the following ingress protection:

- IP44 with doors closed
- IP2X with doors open
- IP2X between compartments.

Outdoor enclosures shall have IP65 ingress protection with doors closed.

1.7 Enclosures containing heat-generating equipment shall be ventilated to prevent thermal damage to any equipment, and to prevent the temperature within the cabinet from exceeding the maximum allowable temperatures of the equipment and materials in the enclosure.

1.8 Wood or artificial wood products shall not be used inside enclosures as mounting panels or for partitions, except in accordance with Clause 3.1 (e).

1.9 Sufficient space shall be provided in enclosures for internal wiring, incoming and outgoing cabling, and cabling for any future circuits.

1.10 Whilst certain equipment may be installed abutting, undue cramping of wiring and equipment is not permitted. A minimum clearance of 75 mm shall be maintained between rows of equipment, between equipment and the top, bottom and sides of compartments.

DIN rails shall be installed at least 125 mm apart between horizontal centres.

1.11 For the purposes of evaluating clearances and creepage distances, and hence the size of the enclosure and its compartments, the environment shall be taken as Pollution Degree 3 unless otherwise specified in the Project Specification***.

2. CONSTRUCTION OF FLOOR-MOUNTED ENCLOSURES

2.1 Material and Fabrication

(a) The enclosure shall be fabricated from 3CR12 sheet metal unless otherwise stated on the Project Specification***. Outer panels and doors shall be 2 mm thick and internal partitions 1,6 mm thick.

(b) The sheet metal shall be suitably bent, braced and welded where necessary to form a rigid structure. Holes, doors, covers, rails, framework, etc. shall be accurately formed to provide a true and plumb structure when completed. Where welding is necessary the excess material shall be ground to the parent surfaces to present a smooth and blemish-free surface for painting.

(c) All screws employed in the manufacture of the enclosures shall be grade 316 stainless steel with machined 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. The inserts shall also be manufactured from grade 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.

(d) Enclosures shall be made up of vertically separated sections which shall be divided into compartments to accommodate equipment for motor drives, instrumentation, switchgear for main and sub-main feeder switches, etc.

Each compartment shall be a minimum of 600 x 380 mm totally separated from the adjacent compartments with sheet steel barriers welded or bolted into position and where wiring is required to pass through these barriers, brass crushed holes shall be provided.

(e) A complete enclosure shall be mounted on and bolted to a hot-dipped galvanised 100 x 50 x 6 mm channel steel base with mitred external corners. The fixing bolts shall be 316 stainless steel M10 bolts.

(f) The height of an enclosure shall not exceed 2 100 mm when mounted on its base.

2.2 Doors

(a) The enclosures shall be fitted with doors on the front, back and ends as called for in the Project Specification***.

(b) All doors shall be arranged to stand off from the face/rear of the 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 sections) shall be further stiffened with "top hat" section channels welded to the inside of the door.

(c) 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 Perano, Barker Nelson or equal approved). 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).

(d) 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 avoid damaged paintwork.

(e) 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.

(f) Where coverplates are provided behind the doors, the coverplates shall be adequately recessed 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. The space between the back of the door and the face of the coverplate shall be nominally 80 mm.

(g) Coverplates shall be fabricated as for the doors and shall be further stiffened to compensate for the machine-punched 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 6 mm diameter tapered dowel pins located in holes drilled in the architrave. Each pin shall be fitted with a 1,2 mm thick spacer washer. Both the pins and the washers shall be welded to the cover.

2.3 Corrosion Protection

The enclosures shall be painted with a high quality polyurethane-based powder coat suitable for interior and exterior conditions and applied by electrostatic spray. The sprayed powder coat shall be baked in accordance with the paint manufacturer's specification.

The enclosures shall be painted white internally and a biscuit colour (B64 to SANS 1091) externally unless otherwise stated in the Project Specification***.

The dry film coat shall be as uniform as possible but shall not be less than 50 microns nor more than 100 microns. The finish shall be high gloss with a minimum of surface defects / blemishes, and acceptance shall be at the Engineer's discretion.

2.4 Busbar Chambers

(a) A totally enclosed busbar chamber shall be provided throughout the length of enclosures for main DBs and MCCs. The busbar chamber shall be fitted with front, back and top covers to give full access to the busbars. The top covers shall be bolted on and the front and back covers secured with square-key latches, with one catch per cover being lockable with a padlock.

(b) The busbar chamber shall be so positioned at the top, that each and every connection is easily accessible and sufficient space is provided to easily operate a torque wrench on each bolt / nut.

(c) Dielectric barriers shall be provided in the busbar chamber at every second section. The dielectric may not be split and installed 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 a snug fit. These dielectric barriers may not be employed to support the busbars. The dielectric shall be bolted to the sheet steel at the periphery of the busbar chamber.

The penetrations for circuits into or out of the busbar chamber shall also be provided with similar dielectric barriers at the points of penetration.

(d) Where specified in the Project Specification*** the space normally used for the busbar chamber shall be divided into two separate, totally isolated chambers: a busbar chamber and a wiring channel for signal and communication cabling / wiring.

The wiring channel shall be 100 mm deep and shall be separated from the busbar chamber with a 1,6 mm thick sheet steel partition.

3. CONSTRUCTION OF WALL-MOUNTED ENCLOSURES

3.1 Material and Fabrication

(a) Both flush-and surface-mounting enclosures shall consist of a tray and an architrave frame on which the chassis, front panel and any door are mounted, except that surface-mounted enclosures of width and height both not greater than 400 mm need not have an architrave frame.

(b) Enclosures shall generally be constructed of sheet steel of minimum thickness of 1,2 mm except that cabinets of width and height both not greater than 400 mm may be constructed of sheet steel of minimum thickness of 0,8 mm.

Where called for in the Project Specification***, 3CR12 steel shall be used.

(c) Wall trays of flush-mounting enclosures shall be fitted with expanded metal spot welded to the rear and metal straps welded to the sides to ensure bonding with the structure of the wall.

(d) Trays of surface-mounting enclosures shall be slightly larger than the architrave frame and shall have a return to present a flat surface to the architrave frame.

(e) A mounting panel of 20 mm thick, fine grade, knot-free pine shall be fitted to the back of panels for telephone and electronic building services.

3.2 Doors and Cover Panels

(a) Doors shall be provided for wall-mounted enclosures unless otherwise stated in the Project Specififcation***.

(b) Doors shall be constructed of the same thickness and material as the remainder of the enclosure.

(c) Door hinges shall facilitate removal of doors without the use of tools. Hinge or hinge-pins shall not be removable when doors are closed.

(d) Unless otherwise specified in the Project Specification***, doors shall be fitted with handles and spring-loaded catches without locks.

Where locks are specified, they shall be "Union", "Yale", "Solid" or an approved alternative, with master key facilities for the entire services installation and separate keys for each cabinet. Two keys for each enclosure and four master keys shall be provided.

(e) Where doors are fitted with locks, the operating handle or toggle or the main disconnector or local disconnector shall be accessible and operable without opening the door.

(f) Cover panels shall be secured by means of catches with square keys, or approved equivalent, quick-release fasteners and shall be fitted with chromium-plated knobs to facilitate removal.

Visible nuts shall be chromium-plated dome nuts. Visible bolts, washers or other fasteners shall be chromium-plated. Self-tapping screws will not be permitted.

(g) Cover panels shall have machine-punched openings for instruments and for equipment operating handles and toggles.

Openings shall be provided for spare accommodation which shall be blanked off by escutcheon blanks or clamped steel plates.

4. INSTALLATION

(a) The Contractor shall check the dimensions of access ways and the space provided for DBs, MCCs and other panels on the latest architectural drawings to ensure that the enclosures are appropriately designed.

(b) Unless otherwise stated in the Project Specification***, floor-mounted enclosures shall be mounted over cable trenches. Trench bridging supports shall be provided at the ends of the enclosure and at every second section. The supports shall be manufactured in the form of a top-hat section from 3 mm thick steel and then hot-dip galvanised.

E205 LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR FOR DISTRIBUTION BOARDS, MOTOR CONTROL CENTRES, CUBICLES AND PANELS

1. GENERAL

Switchgear, controlgear and instrumentation shall be rated for the system voltage, frequency, number of phases, load current and applicable maximum prospective fault current as specified on the drawings and the Project Specification***.

2. SURGE ARRESTERS

2.1 Surge arresters shall be provided for each phase in all boards, connected to each phase of the incoming cables.

2.2 Surge arresters shall conform to the relevant SANS codes and other Specifications, shall bear the SABS mark, and shall be solidly earthed directly onto the cubicle earth bar by means of a copper strap and be as short and straight as possible.

3. AIR CIRCUIT BREAKERS (ACBs)

3.1 ACBs shall be of the metal-clad, withdrawable type complying with the relevant codes and specifications. Unless otherwise stated in the Project Specification***, the ACBs shall be three pole.

3.2 ACBs shall have an adjustable thermal overload trip unit and an adjustable magnetic short-circuit trip unit. All trip units shall be direct acting. Both trip units shall be replaceable by units of different ratings.

The ACBs noted on the drawings as "selective" shall incorporate an adjustable time-delay on the magnetic short-circuit trip unit.***

3.3 ACBs shall be designed for trip-free manual closing and electrical tripping of the type specified in the project specification or drawings, e.g., shunt, remote or under voltage tripping; delayed contacts; AC or DC coil voltage***.

3.4 Interlocking shall be provided to ensure that an ACB is fully isolated before access to any live terminals can be obtained.

3.5 ACBs shall be horizontally withdrawable allowing full maintenance and tests without the breaker having to be removed from the withdrawal mechanism.

3.6 Interlocks shall be provided to allow an ACB to be operated in the withdrawn maintenance/test position, and to prevent the circuit breaker from being closed unless fully in the engaged or test position and from being moved when the mechanism is closed.

Special equipment should not be required to remove the circuit breaker from its withdrawal mechanism for transporting. If special equipment is required, it shall be provided with the circuit breaker.

3.7 Lockable safety shutters shall be provided to screen the fixed contacts and shall operate automatically with the movement of the circuit breaker.

3.8 All non-current-carrying metal parts of the circuit breaker shall be solidly interconnected and connected to an earth contact which shall engage with a copper plate connected to the main earth bar of the cubicle, and the arrangement shall be such that the circuit breaker frame is earthed before the circuit breaker contacts engage with the live fixed contacts.

3.9 A mechanically operated "ON/OFF" or ("I/O") position indicator shall be incorporated.

3.10 Facilities for padlocking in the "off" position shall be provided.

3.11 Two normally open and two normally closed spare auxiliary contacts shall be provided, unless otherwise noted. It shall also be possible to install a change-over contact if required at a later stage. Auxiliary contacts shall be capable of making and carrying continuously 1A ac or dc. They shall be capable of breaking 500 VA AC at 0,2 PF and 20 watts DC at an L/R of < 40 ms.

3.12 Where noted on the drawings*** special purpose interlocking (key/mechanical/electrical) shall be provided between ACBs.

3.13 Unless otherwise stated in the Project Specification***, the ACBs shall have a one second fault withstand rating.

4. MOULDED CASE CIRCUIT BREAKERS (MCCBs)

4.1 Moulded case circuit breakers shall comply with the relevant codes and specifications. MCCBs shall be of flush panel mounting type.

4.2 MCCBs with ratings of 100 A and less shall be suitable for mounting on a DIN rail.

4.3 MCCBs with ratings in excess of 100 A for non-motor loads shall each have an adjustable thermal overload trip unit and an adjustable magnetic short-circuit trip unit. Both trip units shall be replaceable by units of different ratings. MCCBs for motor starter circuits shall be of the current limiting type with an adjustable magnetic short circuit trip unit.

4.4 MCCBs with ratings of 600 A or more and MCCBs inside MCC cubicles shall have extension type operating handles, which shall be interlocked with the enclosure compartment doors to prevent the door being opened unless the MCCB is in the off position.

4.5 Mechanically coupled single-pole circuit breakers used as double or triple-pole circuit breakers are not acceptable unless overload releases are internally coupled.

4.6 The fault current interrupting rating of MCCBs shall not be less than the maximum prospective fault current and not less than 5 kA.

4.7 Neutral bars associated with each bank of MCCBs in distribution boards shall be positioned below each bank and shall be wired in the same sequence as the MCCBs.

4.8 MCCBs with shunt release shall have an auxiliary contact arranged to interrupt the shunt release current at the end of the opening operation. MCCBs with an under-voltage release shall be equipped with a time delay relay when specified***.

4.9 MCCBs shall be fitted with the specified number of spare auxiliary contacts.*** Where spare auxiliary contacts are not called for, it shall nevertheless be possible to fit at least one normally open and one normally closed contact or a change-over contact at a later stage. Auxiliary contacts shall be capable of making and carrying continuously 1A ac or dc. They shall be capable of breaking 500VA ac at 0,2 PF and 20 watts dc at an L/R of < 40ms.

4.10 Where called for, MCCBs shall be capable of remote closing using the specified control voltage.***

4.11 MCCBs shall be lockable in the "off" position. A separate locking device may be used for this facility if so stated in the Project Specification***.

4.12 Current limiting MCCBs will not be allowed unless otherwise stated in the Project Specification***.

4.13 Where MCCBs are of the current limiting type the Contractor shall determine, and offer suitable ratings in collaboration with the MCCB supplier, to ensure discrimination and adequate short-circuit current capability. Calculations shall be submitted with the tender indicating the degree of current limiting and discrimination achieved as well as techniques used. Full details shall be submitted of the current limiting characteristics of each MCCB rating offered.

4.14 MCCBs for direct current application shall be of the current limiting type and shall have at least one pole in the positive and one pole in the negative circuit. Where additional poles are required in series to meet requirements of the specified application, the series connections between poles of like polarity shall be such that they cannot be removed without special tools.

5. DISCONNECTORS

5.1 All disconnectors shall be of the "load-break-fault-make" type i.e. be switch disconnectors complying with the relevant SANS specification.

5.2 The disconnectors shall have the ratings specified on the drawings***.

5.3 Disconnectors with ratings of 600 A or more and disconnectors inside MCC cubicles shall have extension type operating handles, which shall be interlocked with the enclosure compartment doors to prevent the door being opened unless the disconnector is in the off position.

5.4 Disconnector handles shall have an integral key lock or padlocking facility.

5.5 The fault carrying capability of the disconnectors shall be equivalent to or higher than the fault level of the associated busbar but not less than 5 kA.

6. SWITCHES AND SELECTOR SWITCHES

6.1 Switches and selector switches shall be switch disconnectors complying with the relevant SANS specification.

6.2 Switches and selector switches shall be capable of carrying, making and breaking the full rated current and of making onto the maximum prospective fault current.

6.3 The fault rating of switches and selector switches shall not be less than the maximum prospective fault current and not less than 5 kA.

6.4 The operating knob and indicator plate shall be manufactured of insulating material and the switch positions shall be clearly and indelibly marked thereon.

6.5 The switches and selector switches shall be provided with substantial contacts and the terminals shall be clearly marked and arranged for easy wiring.

The voltmeter or ammeter selector switch shall be mounted directly below the associated volt or ammeter.

6.6 Voltmeter selector switches shall be arranged so that voltages between phases, <u>and</u> phases to neutral, can be read. Voltmeter selector switches shall be of the break-before-make type.

The voltmeter selector switch shall have one "off" and six "metering" positions and shall be suitable for panel mounting in such a way that the operation knob and indicator plate can be mounted on the front of a panel and the switch itself at the back of the panel.

6.7 Ammeter selector switches shall be of the make-before-break type with one "off" and four "metering" positions arranged to read the current in each phase and in the neutral. When in the "off" position the metering circuit shall be short-circuited.

The physical construction of ammeter selector switches shall conform to that of voltmeter selector switches.

6.8 Switch enclosures shall be provided with an interlocked cover to ensure that the switch is in the "OFF" position before the cover can be opened for inspection or fuse removal. It shall not be possible to close the switch without the cover being closed.

6.9 Switches shall be provided with a clear "ON/OFF" or "I/O" position indicator.

7. BUS-SECTION SWITCHING DEVICES

7.1 Bus-section switching devices shall be interlocked with the incoming switchgear by means of a special-purpose key interlocking facility when specified or indicated on the single-line diagrams.***

7.2 Bus-section switching devices of rating less than 1000 A shall be disconnectors unless otherwise indicated on the single-line diagrams.***

7.3 Bus-section switching devices rated 1000 A and higher shall be air circuit breakers incorporating magnetic short-circuit trip units without thermal overload trip units.

7.4 Busbar selector or change-over switches shall be provided with suitable position indicators.

8. TIME SWITCHES

8.1 The contacts of time switches shall be silver-to-silver or other approved single-pole changeover contacts rated at 16 A and operated by a spring-driven clockwork, electrically wound with a spring reserve of 8 hours minimum.

8.2 Time switches shall be fitted with a manual overriding switch.

8.3 An external bypass switch shall be provided in each time switch circuit.

8.4 Time switches shall have the following features :

- daily programmable with minimum 30 minute "on" and "off" control facilities;

- weekly programmable with day omission facilities of minimum 12 hours, i.e. mornings or afternoons.

8.5 The whole mechanism shall be totally enclosed in a dust-proof enclosure.

9. PHOTO SWITCHES

9.1 Photo switches shall comply with the relevant codes and specifications.

9.2 Photo switches shall have silver to silver or other approved single-pole changeover contacts rated to switch a reactive load of 1800 VA at 230 V and 50 Hz.

9.3 An external bypass switch shall be provided in each photo switch circuit.

9.4 The photo-electric cell shall switch streetlights on when daylight drops to approximately 40 lux and it shall switch off at approximately 80 lux.

9.5 The photo-electric cells shall have a time delay of not less than 30 seconds.

9.6 Photo-electric cells shall be completely waterproof and shall be of robust construction.

9.7 The material of the cover shall not crack, deform or deteriorate in any way whatsoever and shall be colour-fast in all weather conditions.

9.8 The photo-electric cells shall be provided with built-in lightning arresters.

9.9 Samples of photo-electric cells shall be submitted to the Engineer for approval prior to the ordering thereof.

9.10 The prices for the installation of photo-electric cells shall include the supply and delivery and the connection of cables, etc., from the photocells to LV cubicles, DBs or minisubs.

10. FUSE-COMBINATION UNITS

10.1 The fuse-combination units shall be of the switch-disconnector-fuse (SDF) type and shall comply with the relevant codes and specifications, and shall be fitted with high rupturing capacity (HRC) cartridge type fuses-links complying with the relevant codes and specifications.

10.2 SDFs shall be capable of breaking the full rated current and shall have a fault current rating of not less than the maximum prospective fault current and not less than 10 kA for one second.

SDFs which rely on the fuses to reduce the fault current through the switch portion to provide a higher fault current rating are not acceptable.

10.3 Fuse-combination units with the fuses mounted in the cover of the unit, with the cover forming the operating lever, are not acceptable.

10.4 SDFs shall be of the double air-break, quick-make, quick-break type and shall have a spring mechanism smoothly driven by springs on both sides of the mechanism.

10.5 The fixed contacts shall be shrouded and arranged so that when the switch is in the open position the double-break isolates the HRC fuse links so that they can be replaced in complete safety.

10.6 SDFs shall be triple-pole units unless otherwise indicated on the single-line diagrams.***

10.7 All components shall be capable of continuously carrying rated current without excessive temperature rise.

10.8 SDFs shall be provided with interlocks such that :

a) the cover panel cannot be opened whilst the switch is closed; and

b) the unit cannot be operated with the cover open unless an interlock is purposely defeated.

10.9 An SDF shall have a handle and an ON/OFF position indicator mechanically operated by the moving contacts to ensure accurate and positive indication.

10.10 Facilities for padlocking in the "off" position shall be provided.

10.11 In all cases, the top terminal of fuses shall be the live terminal.

10.12 Six spare fuses shall be provided for each rating fitted.

11. FUSE LINKS AND HOLDERS

11.1 Fuse links shall be high-rupturing capacity (HRC) cartridge type fuse links conforming to the relevant codes and specifications.

11.2 HRC fuse link holders shall be of the withdrawable type and shall conform to the relevant codes and specifications.

11.3 Each fuse link and holder shall incorporate a visual inspection eye for fault location.

11.4 Fuses protecting a specific instrument shall be mounted as a group in close proximity to the relevant instrument.

11.5 A label with the rating of each fuse shall be mounted in close proximity to the relevant fuse holder or fuse switch.

11.6 Striker pin switches shall be provided if specified in the Project Specification in order to trip the associated breaker or contactor to prevent the occurrence of single phasing.***

11.7 Six spare fuses shall be provided for each rating fitted.

11.8 The spare fuses shall not be used by the Contractor during erection, commissioning or maintenance.

12. EARTH LEAKAGE PROTECTION UNITS

12.1 Earth leakage protection units shall conform to the relevant codes and specifications.

12.2 All single and three phase socket outlet circuits shall be provided with earth leakage protection devices unless specifically excluded in the Code of Practice for the Wiring of Premises.

12.3 All units shall have test push buttons and, unless otherwise specified or indicated on the single-line diagrams, the sensitivity shall be 30 mA.***

12.4 Earth leakage protection units shall be arranged to disconnect the faulty circuit from both phase and neutral of a single phase system, and from all three phases of a three phase system.

13. CONTACTORS

13.1 All contactors for low voltage shall be of the electro-magnetic operated air-break type with specific requirements as specified in the Project Specification or drawings e.g. ac or dc coil voltage, dip-proofing, latched contacts etc.***

13.2 Contactors shall comply with the relevant codes and specifications. Category AC3 or DC2 shall generally be used, whichever is applicable. Category AC4 and DC3, whichever is applicable, shall be used for heavy plugging and inching duty systems, e.g. cranes, etc.

13.3 Contactors shall have suitable capacities for direct-on-line starting, star delta starting or any other form of starting, whichever is specified in the Project Specification and the drawings.*** The contactors shall be rated for at least 130% of the associated load current.

13.4 Each contactor shall be provided with at least two normally open and two normally closed auxiliary contacts, unless otherwise specified.

13.5 Contactors shall be suitable for remote and automatic operation where specified.*** Where the number of auxiliary contacts required for remote and automatic operation is greater than can be accommodated on the contactor, an auxiliary relay or on additional contactor, shall be provided.

13.6 Each contactor shall be capable of carrying, making and breaking overcurrents during the operating time of its own overcurrent tripping devices at a recovery voltage of 90% of the specified system voltage.

13.7 All Contactors for starting squirrel-cage motors direct-on-line shall be rated to break 10 times the full-load running current of the motor.

The contactor shall be co-ordinated with the short circuit protective device to ensure adequate protection for the specified operational current, voltage and the corresponding utilisation category*** according to Type 2 Co-ordination as per SANS 60947.

E206 BUSBARS

1. Busbars, metal-enclosed busbar trunking systems and connections shall comply with the relevant codes and specifications.

2. The main busbars, distribution busbars, risers and droppers shall be of hard drawn high conductivity copper, having a constant rectangular cross section throughout. They shall be rated as specified in the Project Specification or indicated on the single-line diagrams***, but the rating shall not be less than specified for the main incoming circuit breaker or disconnector. Where busbars are fed directly from a transformer, the busbar rating shall be 125% of the transformer rating.

3. The busbars shall be designed to withstand for 3 seconds the mechanical and thermal stresses associated with the prospective short-circuit current specified in the Project Specification or indicated on the single-line diagram***.

4. Where busbars terminating at the end of switchboards are intended for future extension***, these busbars shall be predrilled to accommodate the extension. Where pre-fitted space is specified for future equipment***, the busbars in the proposed position shall be predrilled and nuts and bolts shall be provided to accommodate the future busbars or cables feeding the equipment.

5. The main busbars shall be mounted horizontally with the longer dimension in the vertical plane. 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 a deviation equal to its own thickness to overlap the adjoining busbar. The length of the overlap shall be equal to twice the width of the bar, and the joint shall be secured with a minimum of 4 hexagon-headed bolts, washers (plain and spring) and nuts. All joints shall be tightened to the correct torque before switchboards are delivered to site, and again checked just prior to commissioning.

6. Spacing of busbars shall not be less than twice the longer dimension of the busbar and not less than 50 mm between busbars, and 150 mm to the enclosure.

7. Busbars shall be mounted on substantial moulded epoxy or resin insulators fixed with robust steel brackets. Bare conductors shall be so spaced that with all clamps, lugs and lead-offs in position, the spacing between any conductor and earth shall not be less than 40 mm. Parallel busbars shall be separated by a minimum distance equal to the thickness of each single busbar. Parallel busbars shall be connected together at spacings of not more than 450 mm to equalise current distribution.

8. The minimum clearances between current carrying parts and between current carrying parts and other metal parts shall be in accordance with the relevant codes and specifications.

9. Busbars shall be mounted at least 100 mm away from the nearest equipment. Special attention should be given to spacing between fuse-switches and busbars.

10. All busbars shall be covered with coloured heat-shrinkable material. The colour shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two coats of coloured insulation paint. Busbar joints shall be covered with a suitable non-hardening compound and then taped with coloured PVC tape. Busbars shall be radius-edged where they change direction. PVC tape shall not be allowed for phase identification.

E207 CURRENT TRANSFORMERS

1. Current transformers shall comply with the relevant codes and specifications and shall be marked clearly and indelibly as specified therein on a rating plate securely attached to the transformer.

2. Each panel shall be equipped with the current transformers as specified in the Project Specification and or drawings. ***

3. Current transformers shall be suitable for a system with an effectively earthed neutral or a non-effectively earthed neutral as specified in the Project Specification***.

4. For current transformers with a system voltage less than 3,6 kV the insulation level shall be determined by the rated short duration power frequency withstand voltage e.g. 2 kV for a 400V system.

5. Current transformers with system voltages greater than 3,6 kV shall be insulated to withstand test voltages defined by the rated lightning-impulse and short-duration-power-frequency voltages and shall be as follows for indoor switchgear :

HIGHEST VOLTAGE FOR EQUIPMENT R.M.S.	RATED LIGHTNING-IMPULSE WITHSTAND VOLTAGE	RATED POWER-FREQUENCY SHORT DURATION WITHSTAND VOLTAGE
kV	**(Peak) kV**	**(r.m.s.) kV**
3.6	40	10
7.2	60	20
12	95	28
24	125	50
36	170	70

6. The short-time thermal and dynamic current rating of current transformers shall not be less than that of the associated circuit breaker, isolator or busbar.

7. The rated primary currents of current transformers shall be 10, 15, 20, 30, 50 and 75 Amperes or their decimal multiples.

8. The current transformers secondary ratings shall be 5A unless otherwise specified.***

9. Current transformers shall be accessible and easily removable. All current transformers of any one type and rating shall be identical and interchangeable with one another.

10. The class of insulation of current transformers shall be Type A (maximum temperature rise 60°k) unless otherwise specified.

11. Protection current transformers shall be of the low reactance type having toroidal cores with fully distributed secondary windings. Turns compensation shall not be utilised on protection current transformers.

12. The error in turns ratio on any tapping of a Class X current transformer shall not exceed ±0,25%.

13. The same set of current transformers shall not be used for both indication instruments and protective relays, separate cores having a low saturation factor (<than 5 preferably) shall be used for metering.

14. The VA ratings shall be sufficient to operate the various metering equipment and relays but shall not be less than 10 VA.

15. The accuracy limit factor of the protection current transformers shall be 15 unless otherwise specified.

16. The following classes of current transformers shall be used.

FUNCTION	DESCRIPTION	CLASS
1. Metering	kVA, kW and KWh meters	0,5

2.	Indication	Ammeters	1,0
3.	Protection	Over-current, earth fault and thermal overload	10P
4.	Special Protection	Differential protection, Restricted earth fault and pilot wire protection	X

17. The arrangement of the current transformer cores with respect to the primary terminals and mechanism of the circuit breaker shall be approved by the Engineer prior to manufacture.

18. Where it is not possible to easily read the rating plates of current transformers, additional rating plates shall be located on the rear inner panel of the breaker cubicle relay compartment for each current transformer where they can be easily read. These shall be a duplicate of the rating plates which appear on each current transformer. In addition the phase colour with which each current transformer is associated shall appear beneath each rating plate. Information shall be provided on the above rating plates to indicate which secondary terminals are associated with which winding. This information shall be in addition to that called for in the relevant codes and specifications.

    The information on the additional plates shall include the relative arrangement of the current transformer cores with respect to the circuit breaker terminals and shall also indicate their polarity.

19. Secondary windings of current transformers shall be earthed to the approval of the Engineer at one point only. Each group of current transformers (i.e. protection, metering, etc.) shall be earthed directly to the earth bar by way of isolating links of the type where the link cannot be removed from the terminal. These links shall be readily accessible and safe with the circuit breaker in the isolated position. They shall not be in a live compartment.

20. All current transformer connections shall be brought to a terminal block in an easily accessible position inside the switchgear relay panel.

    If remote metering is specified in the project specification***, then the metering current transformer shall also be wired to an easily accessible terminal block at the back of each panel. A metering test block with special links shall be provided to make changes to the remote metering circuits possible without the danger of opening the CT's on load.

21. Each LV current transformer shall be of the ring type and be provided with a robust mounting bracket and approved terminal studs on the circumference of the coil for the connections. The current transformers shall be mounted on rigid supports in such a manner that the axis of the coil is in a vertical plane to facilitate the threading through of the interconnecting wiring to the relevant switchgear.

22. Current Transformer Testing

Test certificates shall be submitted to the Engineer and be included in manuals. Test shall be executed in accordance with the relevant codes and specifications.

22.1 Type Tests

Type tests are not required if the manufacturer holds certificates of type tests on a similar transformer. Type test certificates shall be provided upon request by the Engineer.

22.2 Routine Tests : General

22.2.1 Verification of terminal markings and polarity tests.

22.2.2 Insulation test shall be made on the windings as specified as follows :

- Power frequency tests on primary windings and measurements of partial discharges.
- Power frequency tests on secondary windings and between sections of primary and secondary windings.
- Overvoltage interturn tests.

22.3 Additional Routine Tests for Measuring Current Transformers

- Tests shall be performed to verify limits of current error and phase displacement.

22.4 Additional Routine Tests for Protection Current Transformers : Class 10P

- Tests shall be performed to verify limits of current error and phase displacement.
- Tests shall be performed to verify limits of composite error.
- Secondary winding resistance corrected to 75°C.

22.5 Additional Routine Tests for Special Purpose Current Transformers : Class X

Routine tests shall be performed to verity and establish the following:

- Rated knee-point e.m.f.
- Exciting current.
- Secondary winding resistance corrected to 75°C.
- Turn ratios.

A magnetising curve shall also be provided to the Engineer for Class X current transformers prior to the installation of current transformers in the switchgear.

23. Witnessing Of Tests

It should be noted that inspection and witnessing of tests shall not relieve the Contractor of his responsibilities for meeting all the requirements of the specification, and it shall not prevent subsequent rejection if such material or equipment is later found to be not in compliance with the specification.

24. Additional Information To Be Submitted With The Tender

The manufacturer shall submit with the tender the following additional information:

- A typical drawing showing the assembly of the current transformer and its core and winding.

25. The following colours shall be used :

NUMBER OF PHASES	PHASE COLOUR	NEUTRAL COLOUR	EARTH COLOUR	SPECIAL PURPOSE COLOUR
1	Red	Black	Green/Yellow	Orange
2	Red and White	Black	Green/Yellow	Orange
3	Red, White and Blue	Black	Green/Yellow	Orange
4 and more	Any base colour except Green, Yellow and Orange with serial numbers (numerals or words)	Numbered as for the phase colours	Green/Yellow	-

26. The switchgear manufacturer shall provide necessary copper flexible or bar connections between the riser terminals and the cable terminals. The switchgear riser terminals shall be properly tinned.

27. Connections to the busbars shall be effected by means of the correct clamps or lugs with soldered connections or with connections crimped with the correct equipment.

28. The neutral busbar cross-section shall be equal to that of the phase busbars, and may not be reduced without the approval of the Engineer.

29. Unless fully tested in accordance with SANS 60439-1, the current density of copper busbars shall not exceed 2A/mm² for currents up to 1600 A, or 1,6A/mm² for currents above 1600 A.

30. All terminations onto busbars and busbar interconnections shall be bolted with cadmium-plated high tensile bolts, washers, spring washers and nuts. In corrosive areas, substitute lock nuts for spring washers. The largest possible size bolt that will fit into holes in lugs and fixing holes of equipment shall be used in every instance. Bolts shall be of sufficient length that at least two but not more that five threads protrude beyond the nut. Connections shall be kept as short and straight as possible and where dissimilar metals are connected means shall be provided to prevent electrochemical reactions and corrosion.

31. The maximum current density in busbars and connections shall be such that in no part of the switchgear equipment including circuit breakers, isolating equipment, busbars, current transformers, cable boxes, and connections shall exceed a temperature of 60°C i.e. a temperature rise of 20°C at an ambient temperature of 40°C.

32. Busbars shall be properly insulated and sufficiently supported to withstand the maximum fault current at the points where they pass through panels or partitions of the switchboard. This shall preferably be achieved by means of resin bound synthetic wood or similar material with cut-outs which fit tightly around the busbars. The insulating panel shall be firmly bolted to the frame. Busbars or "droppers" that pass through internal partitions in the switchboard shall be similarly insulated and supported.

33. Earth Bars

A main earth bar shall be mounted at the bottom along the full length inside the switchboard and may be bolted to the framework of the switchboard. For back access switchboards, the earth bar shall be mounted at the rear. The steelwork of a switchboard and in particular gland plates shall be solidly and effectively bonded to the main earth bar. Earth bars shall have sufficient ways for all the earth conductors and, in addition, 30% spare space shall be provided.

Switchboards with short-circuit ratings in excess of 5 kA shall be equipped with a copper earth bar with a cross section not less than S = 0,006 x I mm² where “S” is the area in mm² and "I" is the maximum prospective fault current in Amps. However, in main DBs and MCCs, the earth bar shall not be less than 70 mm x 8 mm in cross-section, and shall be fitted with earthing studs in each section of the enclosure.

Switchboards with short-circuit ratings not exceeding 5 kA shall be equipped with an earth bar comprising box terminals with pressure shoes on a rectangular copper bar measuring at least 2,5 mm x 12,5 mm mounted on insulating pedestals. An earthing stud shall be welded to the metal tray of the distribution board. An earthing conductor equal in cross-sectioned area to the incoming earthing conductor shall connect this earthing stud to the earth bar.

34. Busbar trunking

The neutral bar shall have a cross- sectional area equal to the phase bars.

An earthing bar shall be provided.

The busbar trunking shall be finished in the colour as specified in the Project Specification.***

The busbar trunking shall be vermin-proof and noiseless under load and completely maintenance-free.

Busbar trunking shall have rated short-time withstand current for one second equal to the indicated maximum prospective fault current.

The Contractor shall submit type tests for current rating, rated short-time withstand current, and impedance characteristics to the Engineer.

Pressure test low voltage busbar trunking after installation and before commissioning at 2 kV for one minute between phases, between phases and neutral and between phases and earth.

Confirm route access and dimensions on site and compile shop drawings. Submit shop drawings to the Engineer.

Bus trunking installed outdoors, in hostile or hazardous environments shall be IP65 enclosed or as specified***.

Epoxy or polyester moulded, enclosed bustrunking shall be subject to the Engineers approval. Test certificates according to the relevant cables and specification shall be submitted as required.

The Contractor shall allow in the pricing for a complete system including all inter-connectors, flexible links, terminations and suitable brackets to fix the busbars to structures.

E208 LOW VOLTAGE MOTOR PROTECTION AND RELAYS

1. Motors up to and including 55 kW

1.1 All three phase motor contactors shall be provided with three pole thermal overload relays which are selected for the applicable motor ratings as specified***.

1.2 The overload relays shall have inverse time current characteristics which comply with the relevant codes and specifications. Where motors have exceptional long starting times the tripclass shall be selected to ensure that tripping doesn't occur during motor starting.

1.3 The overload thermal relays shall be phase loss sensitive and shall be provided with a manual reset button.

1.4 All three phase motors shall be provided with suitable phase failure relays providing protection against:

- Single phasing.
- Phase reversal.
- Phase angle errors.
- Unbalance supply voltage.

1.5 When motors for pumping installations or submersible pumps are specified, an underload or undercurrent relay with suitable current transformers shall be provided.

1.6 Where relays are mounted inside panels and the trip indicators on the relays are disabled due to the loss of control voltage when cubicle doors are opened, additional signal lamp indicators shall be provided on the cubicle doors otherwise the relays shall be flush mounted on the doors.

2. Motors Larger Than 55 kW

2.1 Motors larger than 55 kW shall be protected with electronic motor protection relays (MPR). The relay shall make provision for the minimum protection functions as follows:

- Thermal overload with thermal capacity memory.
- Single phasing.
- Phase sequence.
- Restart control (The cooling characteristics of the motor shall be accurately simulated to block starting until the motor has cooled down sufficiently for both hot and cold starts).
- Stall protection.
- Underload or undercurrent protection shall be provided for all motors used for pump installations. Where this feature does not form part of the relay a separate relay providing an underload function shall be provided.
- When earth fault and short circuit functions are specified*** the trip signals shall be wired to trip the backup circuit breaker unless positive proof exists that the contactors are capable of breaking the present and future fault currents. Otherwise these trip signals shall be delayed by the MPR to ensure that the fuses blow before the contactor is tripped.
- Special care shall be taken in the selection of motor protection relays when reduced current starters, e.g. soft starters or variable speed drives are specified. Contractors shall submit to the Engineer written confirmation obtained from the manufacturer of the relay that the relay offered is suitable for the application.

- Where relays are mounted inside panels and the trip indicators on the relays are disabled due to the loss of control voltage when cubicle doors are opened additional signal lamp indicators shall be provided on the cubicle doors otherwise the relays shall be flush mounted on the doors.

2.2 When specified*** that the motor windings are equipped with thermistors a suitable thermistor overload relay shall be provided (motors between 55 kW and 150 kW). Care shall be taken that the total resistance of the thermistors when connected in series do not exceed the tripping range of the relay.

The relay shall have contacts for a manual reset button and a LED display trip indicator which shall be mounted on the front of the panel.

Unless otherwise specified the thermistor overload relay shall be suitable to function in conjunction with thermistors with a temperature reference value of 140°C (Class B motor winding temperature rise).

When thermistors are specified*** for winding temperature alarms the thermistor overload relay shall be suitable to function in conjunction with thermistors with a temperature reference value of 130° {Class B motor winding temperature rise}.

2.3 When specified in the Project Specification*** that the motor windings and the bearings are equipped with platinum resistance detectors (RTD's) Pt-100 Ω (Usually specified for motors above 150 kW), a suitable temperature controller for each RTD shall be provided with the following features:

- Adjustable present process temperature value and adjustable set temperature value in separate four digit LCD displays.
- An adjustable alarm output with indicator.
- Temperature range 0 - 150°C.
- Trip indicator.
- Relay control and alarm outputs.
- Dielectric strength : 2 kV for 1 minute.

Unless otherwise stated the temperature controllers for the windings shall be set for the protection of a class B motor winding temperature rise.

i.e.	Alarm	:	130°C
	Trip	:	140°C

The bearing temperature controllers shall be set as follows:

i.e.	Alarm	:	85°C
Trip		:	90°C

When specified*** the unit shall be provided with a 4 - 20 mA output to transmit the process value or other output as may be required.

All the temperature controllers specified for one motor shall all be mounted in a 19 inch rack as a unit and shall be flush mounted on the cubicle door of the relevant motor.

The unit shall be provided with an override key switch to facilitate the exchange of a temperature controller without causing the motor to trip.

Temperature controllers shall be equipped with 2 pole "two in one" 3 wire surge arresters providing protection from phase to earth and from neutral to earth. Surge arresters shall comply with the relevant codes and specifications.

E209 WIRING IN DBs, MCCs AND PANELS

1. In general all internal wiring in the cubicles shall be carried out in 600V PVC insulated copper multi-strand conductors. If the internal ambient temperature of the cubicle is likely to exceed 50°C silicon rubber insulated stranded copper conductors shall be used. The minimum cross-sectional area for control circuits shall be 1,5 square mm and 2,5 square mm for load and CT circuits. The current carrying capacity of conductors shall be determined in accordance with the relevant codes and specifications taking the appropriate correction factors for ambient air temperatures, grouping and condition of use into account.

2. Where several conductors are used, these shall be neatly grouped and bound together in groups not exceeding 10 conductors and shall be arranged in neat vertical or horizontal rows or installed in PVC trunking with slotted sides. Wiring shall follow the board construction features as far as possible without the twisting or crossing of conductors.

3. No joints will be allowed in internal wiring, and all connections to busbars or earth bars shall be made with approved tinned copper cable lugs soldered or crimped to the ends of the conductors and bolted to busbars by means of cadmium-plated high tensile steel bolts and nuts provided with spring washers.

   Connections of conductors to equipment i.e. circuit breakers, isolators or contactors shall be made by a ferrule of correct size or by the soldering of the end of the conductor. Conductors connected to terminal blocks need not to be soldered or ferruled.

   Conductors terminating on meters, fuse holders and other equipment with screwed terminals shall be fitted with pre-insulated lugs. The lugs shall be soldered or crimped to the end of the conductor. The correct amount of insulation shall be stripped from the end to fit into the terminal. Strands may not be cut from the end of the conductor.

   Crimping tools used shall be of the ratchet type and indent an identifying symbol on the terminal insulation.

4. All wiring is to be kept free and away from any exposed terminals or other uninsulated current carrying parts. Wiring shall also be kept free from metal edges and shall be protected where they cross metal edges. Grommets shall be installed in each hole in the metalwork through which conductors pass. Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductors.

5. Only wires of the same potential shall be grouped together and power control circuit wiring shall be in separate wiring channels. Wiring channels shall not be more than 60% full.

6. Wires shall be clearly marked at all termination points in accordance with the numbering of the board manufacturer's wiring diagram, by means of suitable markers.

7. Additional red cable markers marked "T" in white shall also be fitted on wires associated with trip circuits.
8. When the board main disconnector or local disconnector is switched off, no live incoming or other wiring shall be accessible. The incoming terminals shall be screened or inaccessible. Where connections are taken from the incoming sides of the main switch, they shall be screened by a screen marked **"ISOLATE FEEDER BEFORE REMOVING SCREEN".** If any circuits are energised from other sources, clear warning notices to that effect shall be fitted and such terminals shall be clearly marked.

9. All control terminals shall be accessible from the rear, except in the case of front access boards.

10. Where neutral connections are looped between the terminals of instruments a common lug or ferrule shall be used to ensure that the neutral is not broken when the instruments are removed.

11. The supply end connections to all equipment shall always be at the top and the load end connections at the bottom.

12. Solid copper busbars shall be used to connect equipment to the main busbars where the current rating exceeds 200A and shall be insulated by means of at least two half lapped layers of PVC tape.

13. A maximum of two conductors shall be used per equipment terminal.

14. Where small leads are connected directly onto busbars, such as for voltmeters, etc. they shall be provided with a 20A fuse mounted directly on the busbar and a 2 Amp fuse at the piece of equipment on the front of the panel.

15. Unless otherwise approved the following insulation colours shall identify wiring :-

Red phase of 3-phase circuits	-	red
White phase of 3-phase circuits	-	white
Blue phase of 3-phase circuits	-	blue
Live of single-phase circuits	-	red
Neutral	-	black
Earth	-	green/yellow
Alarm circuits	-	orange
AC control circuits	-	red
DC control circuits	-	blue
Instruments	-	grey

16. In DBs and MCCs, accessible PVC wireways shall be provided for wiring between compartments. Signal cabling shall be run in galvanised steel conduit.

17. Internal wiring shall be kept separated from external wiring and, as far as possible, the internal serving of cables entering the enclosure shall be left around conductors until the cable enters the compartment to which it is connected.

18. Low current signal cables shall be kept separate from power cables up to the point where the conductors are connected to the terminals on the equipment. Where required, sheetmetal wireways shall be provided to ensure this separation.

E210 WIRING- AND CABLE TERMINATIONS AND TEST TERMINAL BLOCKS

1. General

1.1 Electrical terminal blocks shall comply with the relevant codes and specifications and shall be indelibly marked as stated in this specification in respect of ratings, conductor sizes and identification symbols.

1.2 Terminal metal parts, bolts and screws shall be of non-corrosive material, enclosed in fire resistant, moulded plastic insulating bodies. No metal part shall project beyond the insulating material to ensure protection against accidental contact by personnel, against short circuits and tracking.

1.3 The terminal blocks shall have a temperature rating of at least T40 for indoor and T55 for outdoor switchgear.

2. Rail-Mounted Wiring Terminal Blocks

2.1 The construction of the terminal blocks and mounting rail shall be of robust construction as to ensure a firm and positive location of the terminal blocks. It shall be possible to add additional terminal blocks or replace blocks within the terminal sequence without having to disconnect or dismantle the terminal block or adjacent terminal blocks, or having to loosen any fastening device at the rear of the mounting rail. The terminal blocks shall be held in position by means of an end barrier or a shield to insulate the open end.

2.2 It shall be possible to use terminals for different sizes of conductors on the same mounting rail. Where smaller terminal blocks occur adjacent to larger terminal blocks, suitable shielding barriers shall be inserted to cover the terminals that might otherwise be exposed.

2.3 Terminals shall be sized and rated to match the conductors that are connected to them.

2.4 Each terminal blocks shall have provision for clip-in numbering or labelling strips to be installed, together with clear protective caps and shall be clearly marked in accordance with the Board Manufacturer's drawings and wiring diagrams.

2.5 All outgoing circuits of the switchboards shall be provided with suitable terminal strips of the shoe clamping type, a rating of at least 15A and wired in such a manner that all incoming cables installed at the site can easily be connected. Terminals which rely on pinch screws rotating on wire strands shall not be acceptable.

2.6 Terminal strips for auxiliary power, control alarm and trip circuits etc. shall be kept separate to ensure that cables can be made off without disturbing power cables.

2.7 Full details and samples of terminal strips shall be submitted to the Engineer for prior approval.

2.8 Petroleum-jelly filled pilot cables shall be terminated and jointed in moisture-proof, blocking type terminations/joints which shall prevent the ingress of moisture, as well as the escaping of petroleum-jelly from the cable. Epoxy-filled terminations and joints will be acceptable. However, prior approval of terminations and joints shall be obtained from the Engineer.

3. Power Cable Terminals

3.1 The terminal strip shall consist of a metal mounting strip onto which cable connecting modules are fixed. The terminals for power cables shall be have bolt fixing, complete with arc shields and suitably rated for the applicable cable sizes. For cables up to and including 10 mm^2, clamp type terminals may be provided, but the type where the clamp screws are in direct contact with the conductor will not be acceptable.

3.2 The terminals for power cables shall be large enough for the terminating lugs of the cable sizes specified.

3.3 Terminals for power circuits, including the neutral connection, shall be arranged in a straight horizontal line with adequate clearance between live and earth connections with the cable lugs fitted. Rigid barriers, not the thin flexible type, shall be provided between terminals.

3.4 Diagonal or vertical arrangement of terminals for power circuits will not be accepted.

3.5 Where aluminium core cables are used, suitable tinned, copper or aluminium lugs with Densal paste shall be used for the termination.

3.6 The cost for the supply and delivery of lugs and paste shall form part of the price for the erection of the cabinets.

3.7 The terminal strip for power cables shall be positioned at least 50mm from the gland plate. The terminals to which a cable will be connected, shall be directly above/below the specific cable gland for bottom/top entry respectively.

3.8 Where terminals are mounted more than 400mm from the gland plate, provision shall be made for bracing and for fixing the leads of smaller cables to prevent vibration.

3.9 The terminals of each individual circuit shall be clearly labelled with the circuit name and number.

4. Test Terminal Blocks

4.1 Switchboards shall be equipped with a test terminal block, when specified in the Project Specification***. The test block shall be mounted directly below the ammeters and voltmeters on the front panel of the board and shall be wired in series with these instruments.

E211 GLANDS AND GLAND PLATES FOR PVC AND PILOT CABLES

1. Glands

1.1 Mechanical cable glands and flameproof glands shall comply with the relevant codes and specifications.

1.2 When specified in the project specification*** glands shall be weatherproof, dust ignition proof, hose-proof or for use on type 'e' enclosures i.e. use in explosive gas atmospheres.

1.3 Glands shall be provided with brass locknuts and double outer sealing in corrosive environments. Areas which are classified as highly corrosive shall be equipped with H-C (Hydrocarbon resistant) or UV-C (Ultra-Violet and chemical resistant) seals as may be applicable.***

1.4 Glands and components shall be manufactured of non-corrosive material such as nickel plated brass.

1.5 Adjustable cable glands of the correct size designation shall be provided in switchboards for all cable types as specified.

1.6 Glands shall be equipped with cable or armour gripping devices as may be applicable and shall be constructed to ensure electrical earthing continuity between the armour of the cable and the gland plate or the metallic structure. Glands shall be provided with an earthing bond attachment of acceptable rating.

1.7 It shall be possible to convert glands for armoured cables to be suitable for unarmoured cables by replacing the cone bush and compression ring with a rubber compression bush and rings.

1.8 Where cables with metal screens or metal sheaths are specified the gland shall be designed to earth the screen or sheath through the gland on the earth bar. It shall be possible to bring earth continuity conductors through glands for ECC cables without having to cut grooves in the barrel or cone bush. Suitable replacement parts shall be used.

1.9 Glands for outdoor use shall be equipped with a waterproofing shroud and an inner seal kit.

1.10 All pilot cable ends shall be made off in glands as prescribed by the manufacturer, of correct size and complete with neoprene shrouds if used outdoors at minisubs or outdoor cubicles. The armouring shall be clamped between substantial tapered sections, which form an integral part of the gland, secured by lock nuts to give a earth connection.

2. Gland Plates

2.1 Gland plates for cable entries to boards will be from above and/or from below as specified in the drawings of project specifications.***

2.2 Gland plates shall be at least 200 mm above the normal floor level.

2.3 Gland plates shall be from non magnetizing material where single core cables are terminated to the boards.

E212 CABLE TERMINATIONS, JOINTS, CABLE END BOXES, ENCLOSURES AND CLAMPS FOR CABLES RATED 3,3 kV AND ABOVE

1. Cable terminations and enclosures shall comply with the relevant codes and specifications.

2. Suitable cable end boxes or terminations and clamps shall be provided for the types and sizes of cables as set out in the project specification.***

3. The Contractor shall confirm with the Engineer the size and type of cable end box or termination to be used, depending on the choice of PILC cable or cross-linked polyethylene cable and copper or aluminium core cable before the manufacture of the panels or switchboards.

4. The type of termination kits and joints used on paper insulated or XLPE cables shall be those recommended and accepted by the cable manufacturers.

5. If approved by the Engineer, heat shrink type cable terminations and joints may be provided.

6. Tender prices for switchgear shall include for the supply of wooden cable clamping blocks to support the cable inside the switchgear panel where heat shrink terminations are used.

7. The switchgear manufacturer shall provide the necessary copper flexible or bar connections between the riser terminals and the cable end box terminals. The switchgear riser terminals shall be properly tinned.

8. Heat shrink terminations shall be completely non-tracking and U.V. stabilized to ensure long life.

9. Outdoor heat shrink terminations shall be equipped with sheds to increase flashover distances as recommended by the supplier for the specific voltage.

10. Where XLPE cables are used, the switchgear manufacturer shall provide suitable tinned lugs, bolts, nuts and washers for the sizes of cables specified.

11. Where paper insulated cables are used, the switchgear manufacturer shall provide suitable cast aluminium or sheet steel fabricated compound filling cable end boxes suitable for the sizes of cables specified.

12. Where applicable cable end boxes with sealed stem bushings shall be provided. Cable boxes shall be large enough for phasing out cables. Special manufactured cable end boxes shall be used for cables larger than 120 mm^2.

13. Terminations or joints shall be packed as complete kits, clearly marked in respect of suitability for cable type, insulation, construction and voltage. Each kit shall be accompanied by a detailed set of the manufacturers' installation instructions. The terminations and joints shall be made off strictly in accordance with these instructions with the correct tools.

14. The Contractor, at the time of Tendering, and in the appropriate schedule, shall state the equipment with which each jointer will be equipped. Failure to complete this schedule may prejudice the Contractor's offer.

15. Only electricians who can provide a Certificate of Competence issued by the manufacturer of the accepted termination and joint kits shall be allowed to make off terminations and joints. Costs incurred due non-compliance shall be borne by the Contractor.

16. The Engineer reserves the right at any stage during the contract to instruct that any completed joint be opened for the purpose of carrying out an interior inspection. Should the workmanship of the joint be such that it fails to pass an inspection, the remaking of the joint shall be carried out at full cost to the Contractor. Should the workmanship pass the inspection the cost of making good the opened joint shall be to the Employer's account.

17. A loop of approximately 7,0 metre long shall be left, where possible, at each cable end where high voltage cables are laid underground for distances exceeding 60 metres.

18. Conductor joints shall preferably be done by means of suitable ferrules which shall be properly sweated onto the conductors. Crimped ferrules will only be allowed if the crimping tools and workmanship are approved by the Engineer. Suitable ferrules flux shall be used for aluminium cables.

19. On underground through joints, suitable ferrules shall be used for connecting the cores together. The strands shall be thoroughly tinned before being sweated onto the ferrules. In the case of aluminium cores, the strands shall be thoroughly tinned and sweated into the ferrules using suitable solder flux.

20. The joining of copper conductors to aluminium conductors shall be achieved by the use of properly tinned and sweated cores and ferrules respectively. The correct type of ferrules shall be used.

21. All cable joints shall be of the water blocking type for the prevention of the ingress of moisture from one cable to the next through the joint.

22. The electrical continuity of all the conductors, screen and armouring shall not be impaired by cable joints and the earth continuity shall be accomplished within the joints, i.e. no

external earth continuity conductor that will be subject to corrosion, is acceptable. The joints shall be completely covered by a watertight sheath to prevent corrosion.

23. Cable ends shall be long enough for the making off of cable ends into cable through-joint boxes and/or cable end boxes. Excessive waste shall be avoided by the Contractor.

24. Cable connections throughout the system shall follow the same phase rotation, and all cores on the system shall follow the undernoted identification:-

Red Phase	:	Core No. 1
Yellow Phase	:	Core No. 2
Blue Phase	:	Core No. 3

25. Where paper-insulated cables are made off into cable end boxes, the lead cover and armouring shall both be made off into a wiped joint. A 70 mm² stranded copper conductor shall be connected to the cable armouring inside the wipe. The copper conductor and armouring shall be properly cleaned and tinned before the connection is made. The other end of the copper conductor shall be connected to the earthing system by means of a suitable tinned lug. Wiped joints may be replaced by a mechanical assembly approved by the Engineer.

26. Compound shall conform to the relevant codes and specifications. Oil filling compounds shall not be acceptable.

27. Where anti-electrolytic cables are used the cable joint boxes shall be insulated from earth by means of rigid PVC pipes to be put over the joint boxes. The open ends of the pipes shall be sealed with a hard-setting bitumastic compound. Where the environment is sandy, the pipes with joint boxes shall be put onto reinforced concrete slabs. The costs for the supply, delivery and installation of the pipes and/or concrete slabs shall be included in the prices for making off the joints.

28. Lead sheets, or other approved material, approximately 75 mm wide, shall be clamped around the high voltage cables at every cable end box and cable joint box and underneath every cable marker. The following information shall be engraved on the sheets.

a)	Voltage, e.g.	:	11 kV
b)	Sizes, e.g.	:	185 mm² Al or Cu.
c)	Designation, e.g	:	Substation 1 - Substation 2

Only the designation shall be engraved if the manufacturer has already printed the other information on the cable.

29. The installation Contractor shall pre-plan the laying of high voltage cables in order to avoid the installation of a through-joints inside premises. No joints inside premises shall be allowed.

30. Sealing of cable ends

The ends of cables which are cut shall immediately be sealed by means of plumbed lead end caps should there be a delay before jointing is to take place.

The sealing of cable ends by means of rubber or bituminised tapes shall not be allowed. Heat shrink caps may be used provided the seal is correctly applied. Where cable ends were left open for 24 hours or more, the cable ends shall be tested for moisture ingress.

E213 SWITCHBOARD ACCESSORIES

1. Control Push Buttons

1.1 General

1.1.1 Push buttons shall comply with the relevant codes and specifications.

1.1.2 Push buttons shall be provided by a single reputable supply and shall be selected for the required rating, contact action, duty, environmental conditions e.g. temperatures and vibrations and mounting characteristics e.g. flush mounted, enclosed, self-contained, illuminated, etc.

1.1.3 All push buttons shall be of the same physical dimension and shall be interchangeable between normally open and normally closed contacts. Push buttons shall preferably also be interchangeable with indicator lamps, key switches, etc. All push buttons shall be provided with replaceable lenses.

1.1.4 Push button terminals shall be suitable for conductor sizes to be used. Push button assemblies mounted on doors of control boards shall be enclosed to prevent inadvertent contact with the terminals and when the doors are open.

1.1.5 Contacts shall be silver-tipped or be constructed of an approved high quality material.

1.1.6 Push buttons shall be labelled by means of removable legend plates clearly indicating it's function. Legend plates shall be interchangeable.

1.1.7 When specified*** keylock push buttons shall be supplied with duplicate keys. The removal action of the key shall suit the application.

1.1.8 Illuminated push buttons shall comply with the specification for indicator lamps and lights.

1.2 Motor Control Centres

1.2.1 All motor control cubicles shall be provided with "STOP/START" push buttons as follows (or as specified in the Project Specification):

- Start Button : Green
- Stop Button : Red

1.2.2 When specified in the Project Specification*** or indicated on drawings the following push buttons shall be provided:

- Trip Reset Button : Black
- Emergency Stop Button : Red with yellow background
- Lamp Test Button : White
- Any Other Function Button : Pale Blue

1.2.3 Start push buttons shall have normally open contacts. Stop push buttons shall have normally closed or normally open contacts, as may be required.

1.3 Switchgear

When specified in the Project Specification*** or indicated on drawings push buttons shall be provided as follows :

- Electricity Controlled Switchgear

	Open Button	:	Green (O)
	Close Button	:	Red (I)
-	Reset Button	:	Black
-	Lamp Test Button	:	White
-	Any other Function Button	:	Pale Blue

2. Signal Lights

2.1 General

2.1.1 Indicator lights shall comply with the relevant codes and specifications.

2.1.2 Indicator lights shall be provided as specified in the Project Specification*** and indicated on drawings.

2.1.3 Similar cluster multi-led (8 chip) long life signal lamps shall be provided for all indications.

2.1.4 LED's shall be selected and rated for the specified control voltage and shall be equipped with a suitable current limiting protection resistor. Each LED shall be provided with a Zener transient protection diode. Suitable LED's are type MDA 22 for AC applications under 110V and DC applications, and type MAC 22 for AC applications above and including 110V as obtainable from Mimic Crafts. Equivalents shall be submitted for approval by the Engineer.

2.1.5 Indicator light lenses shall be of the same size, shall have a minimum diameter of 22 mm and shall be of the front removable screw type. The lamps shall be replaceable from the front of the panel without the use of tools. Indicator light construction shall be suitable for the operating environment and shall be equipped with interchangeable lenses.

2.1.6 Indicator lights shall be labelled by means of a removable legend plate clearly indicating it's function. Legend plates shall be interchangeable.

2.1.7 Two spare lamps shall be provided for each type and colour lamp used on the boards unless otherwise specified.

2.1.8 The spare lamps shall not be used by the Contractor during erection, commissioning or maintenance.

2.2 Motor Control Centres

2.2.1 When specified in the Project Specification*** or indicated on the drawings, the following indicator lights shall be provided:

-	Drive stopped, power available	:	White
-	Drive running	:	Green
-	Drive tripped	:	Red
-	Emergency stop activated	:	Yellow
-	Moisture ingress	:	Blue

2.3 Switchgear

2.3.1 The following lens colours shall be used :

-	Circuit Breaker, Isolator closed or abnormal state	:	Red
-	Circuit Breaker tripped (caution)	:	Yellow
-	Circuit Breaker open (ready for operation)	:	Green
-	Interlocking	:	White
-	Other functions	:	White

Painted lenses shall not be acceptable.

2.3.2 Where indicating lamps are supplied from the substation batteries, it shall be separately wired to an easily accessible terminal block at the back of the board and shall not form part of the wiring of the spring charge mechanisms of equipment or tripping circuits. The indicator lights shall be wired to a lamp test push button mounted on one of the cubicles, preferably a buscoupler or an incomer. The lamp test circuit shall be equipped with a timer (0-10 min) to prevent the unnecessary drainage of batteries.

3. Semaphores

3.1 Semaphores shall be provided if specified in the project specification.***

3.2 Semaphores shall be of the electrically operated, totally enclosed type, suitable for the operation with the specified control voltage.

3.3 The semaphores shall be of the continuously energised type which will take up an abnormal position when de-energised, e.g. 45 deg. to the horizontal.

E214 NAME PLATES AND LABELS

1. Name Plates

All equipment shall be provided with a manufacturer's name plate/plates fixed in an easily accessible and readable position on equipment or inside cubicles showing the following data.

1.1 The manufacturers name or trademark.

1.2 Type, designation or identification number or other means of identification making it possible to obtain relevant information from the manufacturer of equipment.

1.3 SABS or IEC Designation.

1.4 Rated operational voltage.

1.5 Short circuit strength in kA.

1.6 Degree of protection IP rating.

1.7 Maximum current carrying capacity of busbars.

1.8 Maximum current carrying capacity of equipment.

1.9 Voltage transformer ratio (where applicable).

1.10 Current transformer ratio, burden, class and knee point voltage (where applicable).

1.11 Current transformer connection instructions for various CT ratios (where applicable provide separate nameplate close to the relevant terminal blocks).

2. Labelling

2.1 Labels shall generally have black lettering on a white background. Danger and safety notices shall have red lettering on a white back- ground and be in both official languages.

2.2 Labels shall be engraved "trafolite", aluminium or an approved alternative secured with screws, not glue, or in an approved aluminium guide rail.

2.3 Lettering shall generally be 6 mm high except that of "main switch", "hoofskakelaar", "local switch" and "plaaslike skakelaar" which shall be 10 mm high. The lettering of labels indicating names of panels shall be 20 mm high.

2.4 Each cubicle shall also be provided with labels of similar wording at the back of the cubicle.

2.5 Where possible labels shall not be fixed to removable panels or doors.

2.6 The manufacturer shall consider the wording on the drawings as preliminary only and shall obtain the correct final wording from the Engineer before the labels are manufactured.

2.7 All equipment situated inside the board, e.g. contactors, relays, fuses, timers and time switches, shall be clearly labelled indicating function and circuit controlled.

2.8 Typical labels are as follows :-

2.8.1 Cabinet: cabinet description.

2.8.2 Incoming cables/busbar: size and origin.

2.8.3 Main disconnector: "main switch", "hoofskakelaar" and danger notice.

2.8.4 Local disconnector: "local switch", "plaaslike skakelaar" and danger notice.

2.8.5 Fuses and combination fuse switches: circuit designation and fuse rating.

2.8.6 Circuit breakers: circuit designation and overcurrent adjustment where applicable.

2.8.7 Earth leakage protection units: circuit designations.

2.8.8 Contactors, relays, time-switches, timers, control fuses, etc: designation of control circuit and circuits controlled, function and fuse ratings.

2.8.9 Push buttons: circuit designation and function.

2.8.10 Indicating lamps: circuit designation and condition.

2.8.11 Instruments and selector switches: circuit designation and phase colour.

2.8.12 Meters (kVA and/or kWh): circuit designation and phase colours where applicable, reading description, and a single multiplication factor for each reading.

2.8.13 Terminal blocks: terminal designations and function.

2.8.14 Current transformers: ratios and terminal designations.

3. Legend Cards for Distribution Boards or Cubicles and Motor Control Centres

3.1 Install an index card in a holder, with a 2 mm thick transparent acrylic panel, screwed or welded inside a door, or where no doors are fitted, to the front plate of the cabinet. The legend card shall list the outgoing circuit designations in accordance with the layout and schematic drawings, functions and outlet locations.

E215 METERING AND INDICATION EQUIPMENT

1. General

1.1 All meters and indicating instruments shall be of the flush mounted type. Meters not designed for flush mounting, shall be mounted on suitable brackets inside the equipment panel for relay panels, control panels and distribution boards. A suitable door with a glass-covered window shall then be provided in front of the meter.

1.2 Metering and indicating instruments shall be mounted at between 1,2m and 2m above floor level, except where the dimensions, type and mounting position of the panel make this impossible.

1.3 All meters shall be protected with suitable fuses.

2. Ammeters

2.1 Ammeters shall be of the flush mounted, 96mm square, quadratic scale type unless otherwise approved by the Engineer.
2.2 Ammeters shall comply with the relevant codes and specifications.
2.3 All ammeters shall be of the combined instantaneous and 15 minute integrating time lag thermal demand type unless otherwise specified in the project specification. The instantaneous movement shall be of the moving iron type to Accuracy Class 2,5 of BS 89. The accuracy of the thermal demand movement shall be within 3%.

2.4 The ammeter full scale reading shall correspond with the rated primary current of the associated current transformer with an extended scale to at least 120 % of the full scale value.

2.5 The scale plates of ammeters shall be marked with a red line at the full load current of transformers and motors, and at the associated current transformer primary rating in all other cases.

2.6 Ammeter movements shall be suitable for use in either 1 A or 5 A current transformer secondary circuits as specified*** in the project specification.

2.7 Ammeters shall be fitted with zero adjustment screws.

2.8 Each ammeter shall be clearly marked with the appropriate colour of the phase to which it is connected.

2.9 Where ammeters are to be used with dual ratio current transformers, loose scale plates shall be supplied for each ratio. The ratio shall be indicated on the scale plate.

2.10 Ammeters shall be mounted in a horizontal line on cabinets and cubicles.

3. Voltmeters

3.1 Voltmeters shall be of the suppressed zero, 96 mm square, quadratic scale, flush mounted type, unless otherwise specified.

3.2 Voltage transformers will not be used on 400/231V systems. On all higher voltage systems, the voltmeters shall be supplied from voltage transformers with 110V secondary windings.

3.3 Voltmeters shall comply with the relevant codes and specifications, and shall be of Accuracy Class 2,5.

3.4 Voltmeter scales shall extend to at least 115% of the nominal system voltage. The nominal system voltage shall be clearly marked with a red line on the scale plate.

3.5 All voltmeters shall be fitted with zero adjustment screws.

3.6 All voltmeters shall be equipped with a voltage selector switch. This selector switch shall be suitable for phase to phase selection on high voltage three-wire systems and for both phase to phase and phase to neutral selection on low voltage four-wire systems. The selection switch shall be mounted directly underneath the voltmeter.

4. kWh, kW Maximum Demand, kVA Maximum Demand And Combined kWh / kVA Maximum Demand Meters

4.1 Three and single phase kWh meters, up to 80 A shall be directly-operated types and those above 80 A shall be operated through current transformers.

4.2 kW and kVA Maximum demand meters and combined kVA/kWh meters shall be operated through current transformers.

4.3 All the above types of meters shall be of the directly-operated voltage type for voltages up to 400/230 V unless otherwise specified. Meters to be used on higher voltage systems shall be operated through voltage transformers with 110 V secondary windings.

4.4 kWh-Meters shall have cyclometer dials and shall be direct reading without the use of a multiplication factor. kWh-Meters or combined kWh/kVA maximum demand meters can, however, be of the non-direct reading type, but in this case, only one multiplication factor shall be used to obtain both the kWh and kVA readings.

4.5 Any multiplication factor applicable to any meter shall be clearly indicated on the meter, or on a label adjacent to the meter, in unit form and not as a combination of several factors. The manner in which this factor is calculated shall however also be displayed indicating the CT and VT ratios used.

4.6 All meters shall be fitted with security seal fitting facilities.

4.7 Maximum demand indicators shall be resettable from the front without the removal of any covers being necessary, and shall have security seal facilities.

4.8 The integrating period on all maximum demand meters shall be 30 minutes, unless otherwise specified.

4.9 Combined kVA maximum demand and kWh meters shall be the relevant codes and specifications suitable for the type of system in which it is to be used.

4.10 Meters shall comply with the the relevant codes and specifications. with Class 2,0 accuracy, unless otherwise specified.

5. Power Factor Indicators

5.1 Power factor meters shall comply with the relevant codes and specifications.

5.2 The meter shall be suitable for use on 3 phase, 3 or 4 wire system. Unbalanced conditions shall be allowed for.

5.3 Where power factor indication is specified in the project specification, only one meter shall be provided on each circuit where indication is required. The meter shall be installed on the Yellow phase circuit.

5.4 The meter shall be suitable for operation with the current and voltage transformers specified.

5.5 The scales of power factor indicators shall be calibrated at least from 0,6 leading to 0,6 lagging, or a wider range.

5.6 Power factor indicators shall be of the 96 mm square, or larger, flush mounted type.

E216 EARTHING

1. General

Bond and earth the services installation and extraneous conductive parts. The design and installation of an earth electrode shall be in accordance with the relevant codes and specifications. The services installation shall be bonded by means of earth conductors to the earth electrode via the earth bar.

2. Earth Electrode

2.1 Array of Earth Rods

Earth rods shall be at least 16mm diameter and at least 1,5m long and shall be of solid copper. Install each earth rod in a pre-drilled 50mm diameter hole. Fill with mud slurry after installation.

An array of earth rods shall be interconnected with 70mm² bare, stranded copper conductors buried 700mm underground. The earth rods shall be spaced at least 1,5m apart and not less than the depth of the rods below final ground level.

Unless otherwise noted, the array of earth rods shall consist of five rods, four in the form of a 3m square with a fifth in the centre. The interconnections shall form the sides of the square and shall form a cross thus connecting the centre earth rod.

2.2 Trench Earths

Trench earths shall comprise 70mm² bare, stranded copper conductors buried underground at a depth of a least 700mm below finished ground level.

Unless otherwise noted the trench earth shall comprise conductors extending 50m in four directions at right angles to each other, and connected at the centre.

2.3 Earth Mat

An earth mat shall comprise 70mm² bare, stranded copper conductors buried underground at a depth of at least 700mm below finished ground level in the form of a flat spiral of 24 turns spaced 25mm from each other thus approximate a circle of 1,75m diameter.

3. Earth Bar

3.1 Provide an earth bar in each LV switchroom for the bonding of the earth electrode, main distribution board earth bar, water mains, any Supplier's earth terminal, any transformer's neutral terminal and tank earth terminal and any HV switchgear frame.

The earth bar shall comprise a 50mm x 6,3mm copper section 500mm long with pre-drilled 10mm holes for connection bolts. Mount the earth bar in the cable trench on spacers away from the wall.

Connect the earth conductors to the earth bar by means of soldered or crimped lugs and 10mm diameter cadmium-plated steel bolts.

3.2 The earth conductors to the earth bar from the main distribution board, earth electrode, water mains, and transformer tank shall comprise 70mm² bare stranded copper conductor. The earth conductor to any transformer's neutral terminal shall comprise a 70mm² PVC-insulated copper conductor.

4. Earth Continuity

4.1 Provide earth continuity conductors to earth outlet and each metallic appliance and luminaire.

4.2 The earth continuity conductors shall be separate bare or green PVC-insulated copper conductors when associated with wiring in wireways.

4.3 2,5mm² Earth continuity conductors shall be green/yellow PVC-insulated.

4.4 With a multi-core cable circuit, the earth continuity conductor may be a separate core of a multi-core cable identified with green sleeves at each end.

4.5 Where earth continuity conductors are looped between outlets the looped ends shall be twisted and ferruled without breaking the electrical or mechanical continuity of the earth conductor.

5. Bonding

5.1 Bond the water main to the earth bar where non-metallic pipes are used and connect the water meter and valves to the earth bar.

5.2 Bond metallic cold and hot water pipes, waste pipes, sanitary appliances, ventilation pipes and ducts by means of 12mm x 0,8mm solid or perforated copper tape (not wire) clamped by means of brass screws and nuts.

5.3 Bond metallic roofs, gutters and downpipes to earth by means of 12mm x 0,8mm solid or perforated copper tape clamped by means of galvanised bolts and nuts.

5.4 Do not use self-tapping screws for any earthing or bonding functions.

5.5 Complete bonding work before painting.

5.6 Route copper bonding conductors on the outside of the building in securely fixed galvanised pipe from 2 000mm above ground level to 300mm below ground level.

6. Testing

6.1 Measure the resistance between the earth electrode and the mass of the earth by one of the methods described in the relevant codes and specifications.
6.2 Test the earth and bonding continuity in accordance with the Wiring Code.

6.3 Submit all test results to the Engineer in a written report before any permanent paving is provided over the earth electrode.

7. Earthing Of Fences

Earth the fence of outdoor transformer and/or switchgear installations by means of a 70mm² bare, stranded copper conductor 400mm below ground level and 500mm outside the fence around the whole perimeter of the fence. At each corner, bond the perimeter conductor to the fence pole and to a 1,8m earth rod by means of a 70mm² bare, stranded copper conductor.

Bond the perimeter conductor to the main earth bar by means of a 70mm² bare, stranded copper conductor.

E217 WIREWAYS

1. General

Metallic wireways shall be electrically continuous and the maximum resistance between any two parts shall not exceed 1 ohm.

Wireways shall be mechanically continuous providing a degree of protection of at least IP3 X (that is providing protection against the entry of solid objects exceeding 2,5 mm diameter).

Unless otherwise required conduit installations shall provide a degree of protection of IP44, that is dust and splashproof. Exterior conduit installations shall provide a degree of protection of IPW65 (that is dust-tight, and hose and weather proof).

Where cabling is to be installed afterwards by others, provide galvanised steel draw wires in the wireways.

Space metallic wireways at least 160 mm and non-metallic wireways at least 300 mm away from gas, steam, hot water or similar piping. Prevent wireways from contacting piping so as to avoid electrolytic corrosion.

2. Conduit

2.1 General

No conduit shall be smaller than 20 mm diameter.

2.2 Types of Conduit and Applications

2.2.1 BLACK ENAMELLED STEEL CONDUIT

Black enamelled steel conduit shall comply with the relevant codes and specifications for both screwed metal conduit and plain ended metallic conduit.
Black enamelled steel conduits may generally be used except:-

a) where exposed to the weather

b) where cast into concrete slabs in contact with the soil

c) where exposed to damp or corrosive environments

d) where "U" traps are formed

e) within 50 km of the coast

f) in kitchen and boiler rooms (in which locations galvanised steel shall be installed)

g) in animal houses

h) where protecting underground earthing conductors.

i) in plenums containing humidified air.

2.2.2 GALVANISED STEEL CONDUIT

Galvanised steel conduit shall comply with the relevant codes and specifications screwed metal conduit and plain ended metallic conduit and shall be hot dip galvanised to the relevant codes and specifications.

2.2.3 PVC CONDUIT

PVC conduit shall comply with the relevant codes and specifications and shall be installed strictly in accordance with manufacturer's recommendations. All PVC conduit and associated fittings and accessories shall be of one manufacture.

PVC conduit may only be used strictly in accordance with SABS 0142 and where:-

a) specifically noted or permitted by the Engineer,
b) not exposed to temperatures in excess of 50°,
c) not exposed to mechanical damage, and
d) not used to support any loads.

2.2.4 FLEXIBLE CONDUIT

Flexible conduit shall comply with the relevant codes and specifications and shall be constructed of metal-reinforced self-extinguishing plastic metallic flexible conduit with a sheath of self-extinguishing plastic. The internal diameter shall not be less than 15 mm. Flexible conduit connectors shall securely grip the conduit and be manufactured of zinc, or cadmium Plated steel, or brass.

Where flexible conduit is run in ceiling spaces which form air conditioning plenums, the flexible conduit shall be of galvanised, corrugated steel construction with no PVC components.

Flexible conduit shall terminate on a conduit box unless a draw box exists within 2 metres.

2.3 Installation of Conduit

2.3.1 GENERAL

The interior surface of conduits shall have no sharp protrusions. Fit brass bushes to steel conduit ends. Bond metallic conduit installations to earth and ensure earth continuity not exceeding 1 ohm. Fit lock nuts to running joints. Swab conduit cast into concrete to remove all traces of moisture.

Plug open conduit ends and exclude ingress of dirt and moisture.

2.3.2 CONCEALED CONDUIT

Unless otherwise specified, conduits shall be concealed by being cast into concrete or built into brick or blockwork as applicable. Chasing may only be carried out with the express permission of the Engineer and builder.

Route conduits in structural concrete as close as possible to the neutral axis and secure the conduits against movement.

2.3.3 SURFACE MOUNTED CONDUIT

Where surface mounted conduit is specified, it shall be fixed with spacer bar saddles. The maximum distance between saddles shall not exceed 2 m for steel conduit and 1 m for PVC conduit. A saddle shall be installed within 100 mm of a conduit box.

Remove labels from surface mounted conduit.

2.3.4 ROUTING OF CONDUIT

Conduit in roof spaces, ceiling voids and exposed areas shall be routed parallel and at right angles to structural elements with no diagonal routing.

Wherever possible, conduits shall be run in straight lines with easy curves and shall be drained. Manufactured bends except for 50 mm diameter conduit, and joints at bends, shall be avoided. The minimum radius of a bend shall be four times the conduit diameter.

2.3.5 TERMINATIONS OF CONDUIT

Terminate conduits to luminaires, appliances, conduit boxes and bonding trays as follows:-

a) Concealed Steel Conduit:

i) with two locknuts and a brass bush, or,

ii) with one locknut and a brass bush nut.

b) Surface mounted Steel Conduit:

With a coupling on the outside and a locknut and a brass bush or a brass bush nut on the inside.

c) PVC Conduit:

With a PVC threaded adapter and lock nut with no stress on termination.

2.3.6 CORROSION PROTECTION OF CONDUIT

Paint exposed running threads of black-enamelled steel conduit to be cast or built in with two coats of red lead primer or lap with PVC-insulation tape.

Paint exposed running threads of galvanised steel conduit with two coats of zinc-rich paint.

Provide at least 25 mm of cover to conduits cast into concrete.

Where the paintwork of black-enamelled steel conduit is damaged, prepare the surface and apply two coats of zinc-chromate primer.

Where the galvanising of galvanised steel conduit is damaged, prepare the surface and apply two coats of zinc-rich paint.

2.3.7 FUTURE EXTENSIONS

Provide galvanised steel conduit where future extensions are required. In roof spaces, terminate conduit stubs 40 mm above tie beams and where 900 mm clearance exists.

In concrete terminate conduit 150 mm beyond the concrete in the required direction and provide a draw box within 2 metres. Thread conduit ends and screw on a coupling and brass plug.

Where conduits are exposed, prepare the surface and apply two coats of calcium plumbate primer.

3. Conduit Boxes

3.1 General

Conduit boxes and their cover plates shall comply with the relevant codes and specifications as applicable. Strong mounting lugs and sufficient conduit knockouts shall be provided.

Metallic conduit boxes may be malleable iron or pressed steel and shall be galvanised where used with galvanised steel or PVC conduit.

Where conduit boxes are installed on the exterior they shall be galvanised, primed and painted steel, or malleable iron, or of suitable non-metallic construction and shall be dust, hose and weatherproof to IP65.

Where the temperature may exceed 60°C, for instance where incandescent or other luminaires are mounted against an outlet box, ordinary PVC boxes shall not be installed but steel, or heat-resistant non-metallic boxes shall be installed.

3.2 Blank Cover Plates

Fit blank cover plates to draw boxes and unused outlet boxes

The finish of blank cover plates to wall-mounted boxes shall match that of switch and socket outlet plates.

Install cover plates to ceiling-mounted boxes accurately flush with the ceiling and before painting of ceilings.

Install suitable brass cover plates to floor-mounted boxes accurately flush with the floor finish. The brass cover plates shall be sufficiently thick and reinforced to be rigid, shall be secured with countersunk brass screws and shall be sealed with a gasket

Fit non-metallic cover plates with nylon screws to PVC conduit boxes.

Where boxes have been installed with fixing lugs below the finished wall surface fit spacers of coiled steel wire or of pipe as necessary.

3.3 Draw Boxes

Provide draw boxes to facilitate the drawing in of cables and particularly: -

1) after 180° of bends, and

2) after every 15m of straight runs.

Locate draw boxes to avoid spoiling the appearance of the building. The location of draw boxes shall be accepted by the Engineer.

Where several conduits on the same route require draw boxes a single, large draw box shall be provided.

3.4 Expansion Joints

Ascertain the location of structural expansion joints and install conduit expansion joints where conduits have to cross structural expansion joints.

The conduit expansion joints shall be arranged with a draw box as shown on the attached drawing.

Where several conduits on the same route cross a structural expansion joint a single, large draw box shall be provided.

The gap between the inner conduit and outer conduit sleeve shall be sealed with a suitable sealing compound.

3.5 Conduit Boxes related to Architectural Features

Where conduit boxes are to be mounted on wall or ceiling panels, tiled surfaces, panelling or other finishes, ensure that such boxes are installed symmetrically. Measure and co-ordinate such positions on site. It will not be sufficient to scale such positions off the drawings.

Where several outlets are close to each other, space them evenly and align them.

4. Trunking

4.1 General

Metallic trunking shall comply with the relevant codes and specifications.

Steel trunking shall be manufactured of at least 1,6 mm thick steel and galvanised to the relevant codes and specifications as appropriate. Where painting is required, prepare, apply a calcium plumbate primer and apply two coats of high gloss enamel paint, or apply a powder coating. All the painting shall be done in accordance with the relevant codes and specifications.

Where steel trunking is cut to length on site, render the edges smooth, prepare the surface, apply two coats of zinc-rich paint, and if painted, reinstate the paint system.

Light steel trunking may only be installed where specified and shall be manufactured of are least 0,8 mm thick steel epoxy polyester powder coated to the relevant codes and specifications.

Unless otherwise specified, provide bridges of 32 mm dia. conduit for each compartment between trunking routes and between trunking and distribution boards, telephone and communications panels.
Aluminium trunking shall be anodised to the relevant codes and specifications.

4.2 Installation

Install trunking complete with end caps, outlets, internal splices, covers, internal partitions, 2 clips, knockouts, adaptors, cable retainers, suspension rods, fixings, brackets, clamps, hangers, nuts, bolts, washers, screws and all other accessories required to complete the installation.

Install cable retainers at spacings of not more than 1 metre.
At changes of direction (elbows, tees, cross-overs, etc.), provide internal splices and exterior covers to present a smooth appearance.

Snap-in covers may be used on trunking up to 70 mm wide. Trunking wider than 70 mm shall be fitted with machine screws secured with retained nuts at sufficient points to prevent distortion of the cover.

Support trunking to prevent deflection beyond 1/180th of the span or beyond 3 mm whichever is the lesser.

Provide partitions to separate different services as required.

4.3 Power Skirting

Power skirting shall have 3 partitioned compartments unless otherwise specified.

Power skirting shall allow access to the telephone compartment without any danger of contact with live parts.

Provide cabling throughout power skirting and with sufficient slack to facilitate the addition and repositioning of outlets.

Powerskirting shall be finished in the scheduled colour.

4.4 Underfloor Ducting

Underfloor ducting shall have 3 partitioned compartments unless otherwise specified.

Outlets shall allow access to the telephone compartment without any danger of contact with live parts.

Samples, shop drawings and complete technical literature with approvals, shall be submitted to the Engineer.

Install the underfloor ducting within an accuracy of ± 12 mm from the positions shown on the drawings. Prepare dimensioned "as-built" drawings of the installation.

Install the underfloor ducting complete with elbows, tees, cross-overs, outlets, outlet pedestals, end caps, adapters, fixings, and all other accessories required to complete the installation.
Provide cabling throughout underfloor ducting and with sufficient slack to facilitate the addition and repositioning of outlets.

The installation shall provide a degree of protection of IP 67 (that is dust and watertight) to IEC Publication 162 and be watertight to 12 mm water gauge.

5. Building Elements as Wireways

With the express approval of the Engineer, suitable building elements, such as hollow mullions may be used as wireways provided that:-

a) the wiring is not exposed,
b) metallic building elements are bonded to earth,
c) the building elements are non-inflammable or self-extinguishing, and
d) rewireability is facilitated.

E218 CIRCUITRY

1. Minimum Sizes

The following minimum wiring and cable sizes apply, unless otherwise specified:-

(i) PVC-insulated wiring and cabling for single-phase power and lighting - 2,5mm²
(ii) PVC-insulated wiring and cabling for signal, control, alarm and communication - 1,5mm²
(iii) PVC/PVC/SWA/PVC cabling for three-phase circuits - 1,5mm²

2. Neutral Conductor

A neutral conductor, equal in size to the phase conductors shall be run to each three-phase outlet and appliance unless otherwise specified.

3. Segregation of Circuits

Separate wireways, or separate compartments of multi-compartment wireways shall be provided for the following circuits:-

1) normal power and lighting circuits
2) emergency power and lighting circuits
3) standby power and lighting circuits
4) low voltage (50 V to 1 000 V) control, instrument, signal and alarm circuits
5) extra low voltage (up to 50 V) control, instrument, signal, alarm, fire detection, intercommunication circuits

4. Identification Colours

The following colours shall be used to identify wiring and cable cores:-

- red phase of three-phase circuits - red
- white phase of three-phase circuits - white
- blue phase of three-phase circuits - blue
- live of single-phase circuits - red
- neutral - black
- earth - green/yellow
- alarm circuits - orange
- AC control circuits - red
- DC control circuits - blue
- instrument circuits - grey

Where the colour of conductor insulation is unobtainable, fit correctly coloured sleeves to each end of the conductor.

Three-phase circuits shall be terminated with the red phase on the left, white phase central and blue phase on the right viewed from the front of the switchgear.

E219 WIRING IN WIREWAYS

Unless otherwise specified, wiring shall comprise copper conductor PVC-insulated cable complying with the relevant codes and specifications bearing the SABS mark and rated for 660V general service.

PVC-insulated cable may only be used where the ambient temperature does not exceed 50°C. Use heat-resisting cable complying with SABS 529:1977 where:-

1) temperatures exceed 50°C
2) directly terminated to a water heater, or any other appliance or luminaire which operates at temperatures in excess of 50°C.

Take care not to apply excessive tension to wiring when drawing in and not to cut or abrade cabling.

Where wiring is installed in trunking, ensure it is located in its appropriate compartment to prevent cross-overs. Strap cables together in groups of not more than ten at spacings not exceeding 1000mm by means of suitable strapping.

No joints may be made in PVC/insulated cable except at the distribution board, outlet, appliance or luminaire. Any joints specified or permitted by the Engineer shall comprise sufficiently rated brass terminals in porcelain-insulated shrouds.

Install wiring in wireways after the completion of wireway installation and plaster work but before painting has commenced.

Not more than two circuits of a similar nature will be allowed in one conduit unless otherwise specified.

The wiring of circuits shall be arranged in the loop-in system and not more than four cable ends may be terminated at a termination point.

Cutting away of cable strands or insulation is not allowed.

Where installed in vertical wireways, support the weight of the wiring by means of clamps at spacings not greater than 5m. In conduit such clamps shall be located in conduit boxes.

Where wireways pass through a fire wall, provide a fire barrier.

E220 CABLE TRAYS AND LADDERS

1. General

Steel cable trays and ladders shall be galvanised.

Where painting is required, apply a calcium plumbate primer and apply two coats of high gloss enamel paint to SANS 630, or apply an epoxy-polyester powder coating to SANS 1274.

Cable trays and ladders and their accessories shall be pre-manufactured. On site fabrication will not be allowed without the express permission of the Engineer. Where standard lengths are cut on site, render smooth the cut edges, prepare the surface, apply two coats of zinc-rich paint and if painted, reinstate the paint system.

2. Installation

Install cable trays and ladders complete with cross-overs, tees, reducers, bends, elbows, cornices, splices, traying arms, fixings, brackets, "unistruts", clamps, hangers, nuts, bolts, washers, screws and all other accessories required to complete the installation.

Support cable trays and ladders to prevent sagging beyond 1/180th of the span or 3mm whichever is the lesser. Each length shall be supported in at least two places along the length. The diameter of expanding bolts, studs, etc., and nuts, bolts and patent fixings, etc., securing the trays and ladders shall not be less than 10mm.

3. Heavy Duty Cable Ladders

Cable ladders unless otherwise specified, shall be heavy duty manufactured of sheet steel at least 2,0mm thick with shoulders at least 76mm high. Cable ladders and accessories shall be hot-dip galvanised to SANS 121.

Rungs shall be spaced at intervals not greater than 300mm. Bends, tees, elbows, cross-overs and reducers shall have minimum radii of 450mm.

Support cable ladders on traying arms of length to suit ladder width and fitted with end caps.

Cable ladder lengths over 3m shall be supported in at least three places along the length.

Bolts, nuts and washers securing splice pieces shall be at least 6mm diameter.

Where cable ladders ramp slightly so that a bend is not required provide hinged splice pieces hinging on 8mm nuts, bolts and washers and with radiused corners.

4. Light Duty Cable Ladders

Light duty cable ladders may only be installed where specified or where expressly permitted by the Engineer. These cable ladders shall be manufactured of sheet steel with shoulders comprising 41,3mm x 10mm x 1,6mm pressed steel channels. Cable ladders and accessories shall be hot dip galvanised to SANS 121. Rungs shall be spaced at intervals not greater than 300mm. Bends, tees, elbows, cross-overs and reducers shall have minimum radii of 300mm. Support cable ladders on traying arms of length to suit ladder width and fitted with end caps. Cable ladder lengths over 3m shall be supported in at least 3 places along the length. Changes of direction shall be undertaken with manufactured elbows hinged horizontal splices or hinged vertical splices. Bolts, nuts and washers securing splices shall be at least 10mm diameter.

The hinge pin of the hinged horizontal splice shall be at least 8mm diameter.

Hinged horizontal or vertical splices may be used for elbows and bends up to 45°. Manufactured elbows and bends shall be used for elbows and bends over 45°.

5. Heavy Duty Cable Trays

Cable trays, unless otherwise specified, shall be heavy duty manufactured from perforated sheet steel at least 2,5mm thick with shoulders at least 76mm high. Heavy duty cable tray and accessories shall be hot-dip galvanised to SANS 121.

Provide cornices at changes of direction to allow minimum bending radii of cables.

Support heavy duty cable trays on traying arms of length to suit tray width and fitted with end caps.

6. Light Duty Cable Tray

Light duty cable trays may only be installed where specified or where expressly permitted by the Engineer and shall be manufactured from perforated sheet steel at least 1,2mm thick with shoulders at least 19mm high. Light duty cable trays and accessories shall be galvanised to SABS 121.

Provide cornices at changes of direction to allow minimum bending radii of cables.

Support light duty cable trays on traying arms of length to suit tray width.

E221 ACCESSORIES: LIGHT SWITCHES AND SOCKET OUTLETS

1. Light Switches

1.1 General

Wall switches shall comply with SABS 163 and bear the SABS mark and shall be of the tumbler-operated microgap type. Submit samples to the Engineer for approval.

Wall switches shall be rated for 250V 16A. Install wall switches with the centre 1 350mm above finished floor level

Switch boxes and cover plates shall comply with SABS 1085 and SABS 1084.

Multiple switches may be allowed only if the switches control the same circuit. Switches controlling separate circuits on different phases shall be installed in separate boxes.

Switch toggles or rockers shall operate in a vertical direction.

Where indicating lights are specified, they shall form an integral part of the switch and shall have neon lamps or light-emitting diodes.

Light switches shall be finished as scheduled.

Metallic switch plates shall be secured with two chromium plated countersunk screws. Non-metallic switch plates shall be secured with two nylon countersunk screws.

1.2 Flush Wall Switches

Where conduit is routed flush, install flush wall switches built into conduit boxes.

1.3 Surface-mounted Flush-Pattern Switches

Where flush-pattern switches are to be mounted on the surface they shall be mounted in 100mm x 50mm or 100mm x 100mm by 35mm deep extension boxes.

1.4 Industrial Surface-mounted Switches

The box and cover plate shall be constructed of steel fitting together to make a dustproof assembly, IP44 to IEC Publication 162. The switch toggle or rocker shall be shrouded where it protrudes through the cover plate.

Where required, dustproof industrial surface-mounted switches shall incorporate hinged and sprung dust-proof flaps over the switches.

1.5 Hose-proof Switches

Switches designated hose-proof, weather-proof or waterproof shall be of non-metallic construction and hose-proof to IPW65 of IEC Publication 162. Operation may be rotary, or rocker through a membrane.

1.6 Ceiling Switches

Ceiling switches shall be rated for 250V 10A amp shall be installed on a round conduit box. The base shall be bakelite and the cover of bakelite with a brass screw ring insert.

Provide a 1,25m length of nylon cord.

2. Socket Outlets

2.1 General

Socket outlets shall comply with SABS 164:1953 and bear the SABS mark or with SABS 1239:1979 and IEC 309 as applicable. All socket outlets shall be earth leakage protected. Submit samples to the Engineer for approval.

Unless otherwise specified, socket outlets shall be rated for 250V (phase to neutral) 16A, shall be switched and have safety shutters on the phase and neutral contact tubes.

Where indicating lights are specified they shall form an integral part of the socket outlet and shall have neon lamps or light-emitting diodes.

Install socket outlets with the centres at the following heights above finished floor level unless otherwise noted:-

(a)	generally unless otherwise specified	:	300mm
(b)	hospitals, clinics etc.	:	450mm
(c)	kitchens, laboratories, industrial areas, plant rooms and over work tops	:	1 200mm

Socket outlets shall be finished as scheduled.

Metallic socket outlet plates shall be secured with two countersunk chromium-plated screws. Non-metallic plates shall be secured with two countersunk nylon screws.

2.2 Flush Single-phase Socket Outlets (16 A)

Flush single phase socket outlets shall be rated for 250V 16A and incorporate three contact tubes. They shall be mounted in 100mm x 100mm conduit boxes.

2.3 Surface-mounted Flush-pattern Single-phase Socket Outlets

Where flush-pattern single-phase socket outlets are to be mounted on the surface they shall be mounted in 100mm x 50mm or 100mm x 100mm extension boxes.

2.4 Industrial Surface-mounted Single-phase Socket Outlets

The box and cover plate shall be constructed of steel fitting together to make a dust-proof assembly, IP44 to IEC Publication 162. The switch toggle or rocker shall be shrouded where it protrudes through the cover plate.

Where required, dust-proof industrial surface-mounted socket outlets shall incorporate hinged and sprung dust proof flaps over the switches and contact tubes.

2.5 Moulded Case Circuit Breaker Single-phase Socket Outlets

These socket outlets shall comprise a miniature moulded case circuit breaker and a 250V, 16A 3- contact tube socket outlet mounted in a standard 100mm x 100mm box. The miniature MCCB shall be Heinemann AM1-21, or approved alternative and shall be rated at 10A unless otherwise noted. The assembly shall be Hain catalogue reference SGNY-IO or approved alternative.

2.6 Hose-proof Socket Outlets

Socket outlets designated hose-proof, weather-proof or water-proof shall be hose-proof to IPW65 of IEC Publication 162 when the plug is removed and with the plug inserted.

2.7 Three-phase Socket Outlets

Three-phase socket outlets shall be of the CEE 17, 380V, 6h pattern with 5 contact tubes for three-phases, neutral and earth. Each outlet shall incorporate a switch which can only operate with the plug inserted. Unless otherwise specified, the outlets shall be rated at 16A.

2.8 Stove Connectors

Stove connectors shall be rated for 433/250V, 15A with four contact tubes for three-phases and neutral. Earth continuity shall be provided through the metallic casing of the socket outlet to the metallic casing of the plug by means of a screwing ring.

Stove connectors shall comply with the Appendix referred to in Regulation 707 (13) of the Standard Regulations for the Wiring of Premises.

2.9 5A Single-phase Socket Outlets

5A single-phase socket outlets shall be unswitched, rated for 250V, and have 3 contact tubes with shuttered live and neutral tubes. The socket outlets may be mounted in pre-punched trunking, 63mm dia., 100mm x 50mm or 100mm x **100mm conduit boxes.**

2.10 Shaver Socket Outlets

Shaver socket outlets shall comply with BS 3052 and shall incorporate a double-wound isolating transformer rated at least 20VA and providing 115V and 230V.

The socket contacts shall be suitable for 115V North American pattern plug tops and 230V European pattern plug tops. Insertion of a plug top shall switch on the transformer primary and removal of the plug top shall switch it off.

Overload protection shall be included.

2.11 13A Single-phase Socket Outlets

13A single-phase socket outlets shall comply with SABS 1363.

3. Isolators (Switch Disconnectors) For Building Services Applications

Isolators shall comprise air-break switch disconnectors complying with SABS 152-1977, be double-pole for single-phase circuits and triple-pole for three-phase circuits, and be rated for 433/250V.

The current rating shall be 63A unless otherwise specified.

Isolators for single-phase appliances with loads less than 2,5kVA may have current ratings of 13A.

Where the final connection from the isolator comprises a flexible cord, the isolator assembly shall incorporate an indicating light, a grommet and cord grip or a compression gland, and a fuse rated to protect the cord.

Metallic cover plates shall be secured with two countersunk chromium-plated screws and non-metallic cover plates with two countersunk nylon screws.

The isolators shall be finished as scheduled.

Where indicating lights are specified they shall form an integral part of the isolator assembly and shall have neon lamps or light-emitting diodes.

Isolators up to 63A current rating shall be installed in 100mm x 100mm conduit boxes.

E222 LUMINAIRES

1. General

Provide all luminaires listed in the Schedule and shown on the Drawings including procurement, delivery, acceptance, storage, installation, aiming, adjustment, testing and commissioning.

Luminaires shall be installed complete with mounting accessories, brackets, poles, stirrups, baseplates etc.

Excavate, backfill and consolidate as necessary for luminaires.

Luminaires shall include lamps, indicator lamps, control gear, power factor correction equipment, electro-magnetic interference suppression equipment and all other accessories necessary to render the luminaires fully operative.

Luminaires shall not emit electro-magnetic or radio/television interference in excess of the limitations stipulated by the Department of Posts and Telecommunications.

Luminaires shall have internal wiring of copper conductors of not less than 0,5mm^2, with suitable heat-resistant wiring to SABS 529. PVC insulated wire shall not enter luminaires with polycarbonate components. A terminal block shall be fitted to each luminaire. Luminaires shall each have an earth terminal and shall be bonded to earth.

Each luminaire shall be labelled next to the lampholder and on the control gear with the following information:-

a) voltage rating;

b) lamp type

c) lamp wattage (for incandescent lamps, the maximum wattage).

Control gear shall be power factor corrected to at least 0,9 lagging, shall have a circuit efficiency of not less than 0,85 and shall be silent in operation.

Capacitors shall comply with SABS 1250:1979.

On request of the Engineer, submit luminaire details (including photometric data, and noise level reports) prepared by an accredited laboratory.

On request of the Engineer, remove any luminaire from site and submit luminaire to tests required by Engineer.

Luminaires shall be designed and installed to avoid excessive temperatures. Components and materials shall be so selected that they are not adversely affected by the operating temperature.

The harmonic distortion of a lamp circuit shall not exceed 30%.

2. Installation

2.1 Refer to Section: "Fixing of Materials" of this Specification.

2.2 Install luminaires in accordance with the manufacturer's recommendations.

2.3 Mount luminaires after the first coat of paint has been applied. Await final coat of paint, before completing installation of luminaires.

2.4 Fix luminaires equal to or narrower than 225mm at the centre and two outer positions. Fix luminaires wider than 225mm at the centre and at the four corners.

2.5 Where luminaires butt, fix them together with brass bushes and lock nuts.

2.6 Screw conduits directly to exterior luminaires and to luminaires with a degree of protection in excess of IP44. Provide gasketting and sealants between luminaires and surface to which they are mounted. For wall-mounted luminaires, the conduit shall enter the luminaire at a slight downward angle to the horizontal.

2.7 Where luminaires are mounted on, or in, ceilings made of panels, mount the luminaires symmetrically. Where the mass of the luminaires exceeds the load carrying capability of the ceiling systems, install suitable hangers.

Connections to luminaires mounted on or in ceilings shall comprise metallic conduit, flexible conduit (without a PVC sheath), or silicone rubber flexible cord. Co-ordinate such connections with the Contractors installing the ceiling, air conditioning and other services.

3. Exterior Luminaires

Exterior luminaires shall have a degree of protection of at least IPW65 of IEC-162. Lenses shall be resistant to degradation and discolouration from ultra-violet radiation. Materials shall be corrosion-resistant and selected to avoid electrolytic corrosion. Luminaires constructed of sheet steel or sheet aluminium are not acceptable.

The bodies shall be painted cast-iron; painted, or anodised (Class C), die-cast LM6 aluminium; glass-reinforced polyester; or polycarbonate.

Gaskets shall be silicone rubber or neoprene.

Lenses shall be polycarbonate or heat-resistant glass. Lens, or lens-frame, securing screws shall be stainless steel.

Floodlight luminaires shall incorporate calibrated horizontal and vertical angle scales.

4. Sheet Metal Work and Painting

4.1 Sheet metal work shall be constructed from cold-rolled, rust-proofed sheet steel not less than 0,8mm thick suitably reinforced and braced for rigidity.

4.2 Degrease, de-rust and then phosphate with a light-weight hot phosphating solution in accordance with Section 2.4 of SABS 064:1960.

4.3 Prime with an epoxy zinc-chromate primer. Lightly sand and paint with two or more coats of white acrylic baking enamel and then bake to comply with Type 1 SABS 663:1959.

4.4 An approved epoxy-polyester baked powder coating process SABS 1274:1979 may be substituted for the painting specified above in clause 20.4.3.

4.5 Paint finish shall be smooth, glossy and free from imperfections.

5. Emergency and Standby Luminaires

5.1 Emergency Fluorescent Luminaires (with integral battery)

Each emergency fluorescent luminaire with integral battery shall incorporate a mains-failure relay, battery charger, nickel cadmium battery, and inverter which shall provide emergency lighting by means of one lamp operating at 100% light output for at least one hour. The battery charger shall fully recharge the batteries within 24 hours.

5.2 Mercury Vapour Luminaires on Emergency and Standby Circuits
Each mercury vapour luminaire on an emergency or standby circuit shall incorporate a mains failure relay, change-over switchgear, a photo switch and quartz halogen lamp. The quartz halogen lamp shall operate on mains failure until the mercury vapour lamp has run up when the photoswitch shall extinguish the quartz-halogen lamp.

5.3 High-pressure Sodium Luminaires on Emergency and Standby Circuits

Each high-pressure sodium luminaire on an emergency or standby circuit shall have a lamp with a run up time of not less than 20 seconds.

5.4 Exit Signs

Each exit sign with integral battery shall incorporate two fluorescent lamps each with its own separate control gear, mains failure relay, battery charger, nickel cadmium battery and inverter which shall provide emergency lighting by means of one lamp operating at 100% light output for at least one hour. The battery charger shall fully recharge the batteries within 24 hours.

Exit sign lettering shall be at least 150mm high.

Exit signs shall comply with BS 5266 and BS 2560. Surface-mounted exit signs shall incorporate an aperture of at least 200mm x 50mm with prismatic diffuser to provide downward light.

6. Fluorescent Luminaires

6.1 General

Interior fluorescent luminaires shall comply with SABS 1119:1976.

6.2 Construction

Provide three 20mm diameter knockouts in the backplate, one in the centre and one at each end. Each knockout shall have accompanying slots for screws to fit a standard round conduit box and arranged so that the luminaire can be turned through an angle of 90°C. The backplate shall extend the entire length of the luminaire. Luminaires shall be so constructed that it is possible to reach the control gear without disconnecting any wiring and without removing the luminaire from its installed position.

6.3 Channel Luminaires

Fluorescent channel luminaires shall consist of a ventilated rectangular wiring channel.

6.4 Lenses. Diffusers and Louvres

Lenses, diffusers and louvres shall be sufficiently strong and rigid to resist distortion and breakage during normal operation and maintenance.

Lenses, diffusers and louvres shall be constructed of:
a) flame-retardant acrylic (methacrylate),
b) flame-retardant, UV and light stabilised polystyrene, or
c) UV and light stabilised polycarbonate.

6.5 Components

Ballasts shall comply with SABS 890:1967. Unless otherwise specified ballasts shall be switch-start. Switch-start ballasts shall be wound length-wise around pre-assembled laminations crimped into a steel channel. No compound shall be required.

Starters shall comply with BS 3772/IEC-55 and be accessible for replacement with the lamps in position.

Lampholders shall be telescopic or hinged sprung-ratchet.

6.6 Lamps

Lamps shall comply with SABS 1041:1975. Lamps shall have an average life of at least 7 500 hours on a 3 hour on/off switching cycle. On request submit to the Engineer the light output of the lamps at 100 hours and 2000 hours. The light output at 2 000 hours shall not be less than 80% of the output at 100 hours.

No lamp flicker of lamps shall be visible under normal operation after initial stabilisation period of 100 hours. Lamp colour shall be SABS colour reference 2 unless otherwise specified. 18W, 36W, and 58W fluorescent lamps (26mm diameter) shall be "colour 84" unless otherwise specified.

7. Incandescent Luminaires

Lampholders shall be porcelain.

Lampholders for lamps of 150W and higher rating shall be Edison Screw (E.S.).

The operating temperature within the luminaires shall be limited to avoid any adverse affects on any components.

8. Gas-Discharge Luminaires

Ballasts shall comply with SABS 1266:1979. Ballasts shall be cast in epoxy-resin and provided with heat sinks, cooling fins, etc., to limit the operating temperature to avoid any adverse affects to any components.

Interior luminaires shall comply with SABS 1278:1980.

Mercury vapour lamps shall be of the colour corrected, high pressure, fluorescent type.

High pressure sodium vapour lamps shall be of the colour enhanced type.

E224 POWER FACTOR CORRECTION EQUIPMENT

1. General

1.1 The power factor correction equipment shall in general comply with all the other clauses in the Standard Specification, where applicable.

1.2 Shunt capacitors shall be used for power factor correction.

1.3 The finish and colour of equipment shall be specified in the project specification.***

1.4 Power factor compensation for the electrical equipment shall be done on a individual, group or central basis as specified in the project specification.***

1.5 The power factor correction equipment shall be suitable for the fault level and voltage of the system as specified in the project specification.***

1.6 All equipment including the capacitors shall be suitable for the ambient temperatures and altitude of the site specified.***

2. Individual Compensation of Low Voltage (up to 1000V) Motors

2.1 Capacitors shall preferably be installed inside the motor control centres.

2.2 Internally fused three phase capacitor units shall be used.

2.3 Where capacitors are connected in small banks they shall be "group fused" with suitably rated fuses. Fuses shall comply with Standard Specification E205, Clause 11.

2.4 No additional protection is needed for individual three phase capacitors where the motors to be compensated has motor protection relays installed.

2.5 The motor protection relay settings shall be adjusted taking the capacitor current into account to ensure that proper protection is given to the motor.

2.6 To provide protection to switchgear and capacitors against inrush currents all the incoming cables to the capacitors shall be coiled close to the capacitors with approximately five turns and 50mm diameter to form an inductor.

2.7 The capacitor current shall not be higher than 90% of the no-load current of the motor to ensure that the self excitation voltage caused by the capacitor is lower than the rated voltage of the motor.

2.8 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

3. Individual Compensation of High Voltage (3,3kV And Above) Motors

3.1 Capacitors shall be installed in a free standing cubicle as specified or indicated on drawings***. IP42 enclosure protection is required.

3.2 Suitably rated series reactors shall be mounted on each phase to provide protection to switchgear and capacitors against inrush current surges.

3.3 Internally fused three phase capacitor units shall be used individually or in banks for larger motors.

3.4 High voltage capacitor banks shall be "group fused" with suitably rated BS type fuses mounted in a combined fuse switch. Fuses shall comply with Standard Specification E205, Clause 11.

3.5 A tripping system shall be brought into operation by a blown fuse which shall automatically lock the switch mechanism to prevent closure. The tripping of any single phase shall open all three phases and lock the switch in the open position pending fuse replacement.

3.6 The rating of the fuse switch shall be at least 1,5 times the rated capacitor current.

3.7 The following shall be the maximum kVAr rating per group:

11kV : Maximum 1600kVAr
6,6kV : Maximum 1600KVAr
3,3kV : Maximum 800KVAr

3.8 Fuse trip flag indication on the cubicle and a microswitch for remote indication and alarm purposes shall be provided to indicate fuse blown conditions.

3.9 The capacitor current shall not be higher than 90% of the no-load current of the motor to ensure that the self excitation voltage caused by the capacitor is lower than the rated voltage of the motor.

3.10 The motor protection relay settings shall be adjusted taking the capacitor current into account to ensure that proper protection is given to the motor.

3.11 LED cable alive signal lamps shall be provided on three phases of the incoming high voltage cables to the cubicle.

3.12 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

4. Capacitors

4.1 The capacitors shall comply with IEC 60871, Part 1 for Medium Voltage Capacitors and IEC 60831 for Low Voltage Capacitors.

4.2 The capacitors shall be of the self-healing type.

4.3 Low voltage capacitors shall have dry insulation and shall not contain impregnating liquids.

4.4 The medium voltage capacitors shall not be impregnated with poly-chlorinated biphenyls (PCB).

4.5 The casings shall have suitable earthing terminals.

4.6 Capacitors shall be fitted with terminal covers.

4.7 No toxic gases shall be given off on combustion.

4.8 Capacitors shall have a dielectric efficiency of not less than 99% tested at 70°C.

4.9 Capacitance tolerance : +5; -0% per phase.

4.10 Voltage Rating:

- The capacitor shall be rated to operate continuously at 130% of the nominal voltage (IEC rating plus 20% excess).

4.11 Current Rating:

- The capacitors shall be rated to pass continuously 150% of the nominal rated current (IEC rating plus 20% excess).

4.12 Discharging:

Discharging shall be by means of internal resistors or transformers. The discharging period shall be maximum 5 minutes to reach a voltage of 50V.

4.13 Interlocking:

Interlocking shall be provided to prevent closing of the contactor during the capacitor discharging period.

5. Group or Central Compensation

5.1 Group or Central Power Factor Correction shall consist of the number of kVAr steps as specified in the project specification.***

5.2 Power factor correction equipment shall be installed indoors unless otherwise specified.***

- Indoor Enclosure Protection IP44
- Outdoor Enclosure Protection IP55

5.3 The control of power factor correction equipment shall be such that no leading power factor can occur.

5.4 Where power factor correction is done on a group or central basis the capacitors, control equipment and switchgear shall be housed in a combined free-standing cubicle with suitable lockable doors to gain access to the capacitors.

5.5 The power factor correction equipment shall be complete with all equipment, internal wiring, busbars, labels, current and voltage transformers, etc in accordance with the associated standard specifications.

5.6 All wiring, connections, instruments and other equipment shall be flush mounted inside the cubicle and not on the outside.

5.7 Fuse Arrangements

The following fuse arrangements shall apply:

5.7.1 Capacitor steps shall each be "group fused". The following shall be the maximum step sizes in kVAr rating per group.

11kV :	Maximum 1600kVAr
6,6kV :	Maximum 1600kVAr
3,3kV :	Maximum 800kVAr
400V :	Maximum 200kVAr (100 kVAr preferred)

Internally fused three phase capacitor units shall be provided.

5.7.2 Where kVAr steps exceed the kVAr ratings in Clause 5.7.1 two or more groups which are individually "group fused" shall be provided per step

5.7.3 Where kVAr steps exceed the kVAr ratings hereunder externally fused capacitor units shall be provided:

11kV :	4800kVAr
6,6kV :	4800kVAr
3,3kV :	2400kVAr

5.7.4 The "group fuses" shall be rated to protect the capacitors against rupture and will have a rating of approximately twice the capacitor bank current. HRC fuses shall comply with Standard Specification E205.

5.7.5 A tripping system shall be brought into operation by a blown fuse which shall automatically lock the switch mechanism to prevent closure. The tripping of any single phase shall open all three phases and lock the switch in the open position pending fuse replacement.

5.8 Control Switches and Push Buttons:

- Control switches and push buttons shall comply with Standard Specifications E205 and E213.
- An ON/OFF control switch shall be provided.
- An automatic/manual switch shall be provided.
- When in manual mode it shall be possible to control the power factor utilizing push buttons to switch the capacitor steps.

5.9 Indication or Signal Lights:

- Signal lights shall comply with Standard Specification E213.
- Each stage shall have an indicating light to show which stages are energised and which stages are being called on to energise.
- Signal lamps to indicate alarms, main switch-off and power factor out of tolerance.
- A signal lamp shall also be provided indicating protection relay operated.
- LED cable alive indication lamps shall be provided on the three phases of the incoming high voltage cables.

5.10 Meters

- Meters shall comply with Standard Specification E215.
- Each power factor correction equipment cubicle shall be provided with the

following:

1) 1 x voltmeter with selector switch.
2) 1 x power factor meter.
3) 1 x kVAr meter.
4) 3 x Ammeters

5.11 Alarms

A visible alarm and buzzer with manual override facilities shall be provided on the cubicle to activate the alarm under the following conditions:

1) Main switch switched off and capacitor step fuse blown (power for alarm taken from incoming side of main switch).

2) Power factor out of tolerance (with suitable time delay to give the system time to react to any changes).

5.12 Counters

Each step shall be provided with a non-resettable counter indicating the number of times which a step operated.

5.13 Rotation of Steps

When kVAr banks of the same size are specified the steps to be switched in first, second, etc. shall be rotated.

5.14 Surge Protection

Surge protection shall be provided at the terminals where the low voltage auxiliary power (231V) enter the PFC cubicle as well as at the power terminals of the PLC or Reactive Power Controller. Surge arresters shall be provided on both the Live and Neutral conductors and shall be properly bonded to the earth conductor.

5.15 Busbar and Busbar Trunking

Busbar and busbar trunking shall comply with Standard Specification E206.

Busbar trunking shall only be used for connecting the power factor correction equipment to the electrical system, if specified in the Project Specification.*** If this is not specified, cables shall be used for the interconnections

5.16 Labels shall be provided on all panels containing power factor correction capacitors to warn the maintenance personnel about possible static charges on the capacitors which should be discharged before attempting any maintenance work.

6. Medium Voltage Power Factor Correction Equipment (above 3,3 kV)

6.1 Each capacitor step shall include the following electrical equipment in accordance with the associated standard specifications (number given in brackets):

- Switch-disconnector (E225)
- HRC fuses BS type
- Current transformers (E207)
- Vacuum or SF6 contactors (E226)
- Earthing Switches (E226)

- Series reactors (E226)
- Voltage transformers (if required) (E227)
- Expulsion fuses if capacitors are externally fused.
- Protection relays

Refer also to the relevant standard specifications as indicated pertaining to abovementioned equipment. Unless otherwise specified the rating of equipment shall be at least 1,5 times the capacitor current rating.

6.2 Contactors

Each step shall be individually controlled by a vacuum or SF6 contactor. The contactors shall be restrike-free when breaking capacitive loads.

6.3 Series Reactors

Suitably rated series reactors shall be mounted on each phase of each step to provide protection to switchgear and capacitors against inrush current surges.

6.4 Protection Relays for Medium Voltage Power Factor Correction Equipment:

6.4.1 Each capacitor step shall be provided with a protection relay with the following features:

- Inverse - Time Harmonic Over-current : Maximum THD voltage: selectable 5% or 10%
- Definite - Time 50 Hz Overvoltage : 112%
- Instantaneous 50 Hz Overcurrent : 1,4 x rated capacitor current
- Earth Fault Current 50 Hz : 6 to 60% of rated capacitor current
- Unbalance Current 50 Hz : 1 to 30% of rated capacitor current

Unless otherwise specified*** the ratings of the relay shall be as follows:

- Auxiliary Power Supply : 230 VAC
- Current Transformer Input : 5A

The relay shall also include the following features:

- Trip Relay : 2 contacts
- Alarm Relay : 1 contact
- Trip Indicators : LEDS for all trip functions

The Contractor shall provide to the Engineer a complete set of calculations and recommended relay settings for each step one month prior to commissioning. The Contractor shall be responsible to set the relays on site and to instruct the personnel of the Employer in respect of the operation of the relay. If the Contractor is not familiar with the relay a representative of the relay manufacturer shall be paid by the Contractor to execute this function.

6.4.2 Where capacitor banks or steps of the double star connections is offered a current transformer shall be connected between the two unearthed neutral star points for detection of unbalance currents. A sensitive current relay connected to the current transformer shall be utilised to trip the contactor.

6.5 Reactive Power Control

- The power factor shall automatically be controlled by means of a programmable logic controller (PLC) and a suitable kVAr transducer connected to the current and voltage transformers. The PLC is to be provided with a programming device.

- Under no circumstances shall the program memory of the PLC be lost due to power outages of extended periods or when the system is disconnected and not operational. The PLC shall be equipped with an EPROM I.C. programmed for the specific application after final commissioning.

- The Power Factor Correction (PFC) steps shall be selected based on programmable set points.

The following time delays shall be applicable before each step is switched

Delay Before Switch-in	:	System lagging for 30 seconds
Delay Before Switch-out	:	System leading for 20 seconds

The following current set points shall be applicable :

Switch-in	=	> 1,2x	bank size lagging
Switch-out	=	> 0,3x	bank size leading

- The step switch-in cycle shall take the capacitor discharging time into account when applicable.

- The PLC shall be programmed to provide no-volt or mains failure return control which switch the banks off after a selectable period (0 - 500 ms) after a mains failure occurred.

- Harmonic suppression shall be provided to ensure the PLC is not adversely affected by harmonic currents or voltages.

- Further fail safe operation shall be provided namely that in the event of loss of phase, current transformer failure or control supply (longer than 20 milli-seconds) a control relay shall de-energise all outputs and on restoration set up the sequence from step one after taking a new measurement.

- It shall be possible to set the target power factor and to set an alarm cos ø limit below the set point.

- The PLC software shall be well documented particularly with relation to set points, timers and interlocks.

6.6 Constant Voltage Transformer

- The control circuits of the power factor correction equipment and the supply to the PLC shall be provided with power from a suitably rated constant voltage transformer (CVT) in order to limit malfunctions due to transients and voltage dips on the system. The CVT shall be housed inside the PFC cubicle.

7. Low Voltage Power Factor Correction

7.1 Each capacitor step shall include the following electrical equipment in accordance with the associated standard specifications (number given in brackets):

- Switch-disconnector (E205)
- HRC fuses (E205)
- Current transformers (E207)
- Contactors (E205)
- Harmonic watchdog if specified***.

Refer also the relevant standard specifications as indicated pertaining to abovementioned equipment. Unless otherwise specified the rating of equipment shall be at least 1,5 times the capacitor current rating.

7.2 Protection Relay

A harmonic watchdog relay shall be provided where specified*** with a single channel THD transducer which provide an accurate current loop signal proportional to Total Harmonic Distortion (THD), and with a relay output with adjustable trip level.

- Rated input : 5A
- Rated output : Adjustable 1-50% of rated 50 Hz input
- Current loop output : 4-20 mA = 20% THD of rated 50 Hz input

A suitable harmonic watchdog relay is obtainable from Strike Technologies (Pty) Ltd.

7.3 Reactive Power Control

7.3.1 The power factor shall automatically be controlled by means of Reactive Power Control Relay.

7.3.2 The reactive power controller shall be of the solid state adjustable type suitable for the operating voltage.

7.3.3 The controller shall be flush mounted in the panel.

7.3.4 The regulator shall have no-volt or mains failure return characteristics.

The no-volt or mains failure return control equipment shall also allow the switching off of all banks after a total mains failure occurred, to minimise the total inrush currents to all banks.

7.3.5 Further fail safe operation shall be provided namely that in the event of loss of phase, current transformer failure or control supply (longer than 20 milli-seconds) a control relay shall de-energise all outputs and on restoration set up the sequence from step one after taking a new measurement.

7.3.6 When the measured lagging or leading power factor value exceeds a preset level, a minimum time lag of 20 seconds and maximum of 30 seconds for an on or off switching step shall take place. Switching time from stage to stage shall be independent of the reactive power.

7.3.7 The sensitivity of response shall be continuously adjustable, by current lagging or leading.

7.3.8 Harmonic suppression shall be incorporated as standard to avoid zero crossing error caused by a distorted waveform.

7.3.9 It shall be possible to set the target power factor and to set an alarm cos ø limit below the set point.

7.3.10 The reactive power controller shall also take the discharging time of the capacitors into account when applicable.

7.3.11 To match the controller to various capacitor step sizes and input current transformer ratios it shall be possible to set the activating current by altering the "$^{C}/_{K}$ ratio".

8. Installation and Erection

8.1 The power factor correction equipment shall be properly fixed to the floors or supporting steel work.

8.2 The Contractor shall note sizes and positions of cable trenches and vertical shafts and shall include in his tender all supporting steelwork to straddle trenches and vertical shafts to support power factor correction equipment securely.

8.3 The prices for the erection of power factor correction equipment shall include the making off and terminating of all cables and wires.

8.4 The power factor correction equipment shall be properly earthed to the substation and/or building earthing system.

8.5 When aluminium core cables are used, suitable tinned copper or aluminium lugs with Densal paste shall be used for the terminations.

8.6 The costs for the supply and delivery of the lugs and paste shall form part of the price for the erection of the power factor correction equipment.

9. Routine Tests

Test certificates of capacitors for the following tests shall be submitted to the Engineer:

- Measurement of capacitance.
- Measurement of tangent delta.
- Terminal/Terminal voltage test.
- Terminal/Casing voltage test.

10. Additional Information Required

In addition to details of normal type and routine tests, as well as any other design and test information, Contractors shall submit the following at tender stage:

- Dielectric type (eg. mixed or all-film)

- Maximum element voltage at rated capacitor voltage.

- Maximum field strength in kV/mm calculated with nominal dielectric thickness (i.e. using weight method in the case of plastic film), referred to the nominal element voltage.

- Number of elements in parallel and in series per unit.

- Ratio of partial discharge inception voltage (PDIV) to rated voltage.

- Guaranteed average power losses in watts/kVAr at 40°C.

- Tank rupture TCC curves if external fuses are offered.

11. Drawings

Drawings shall comply with Standard Specification E200.7.

At tender stage Tenderers shall submit general assembly drawings of equipment offered indicating the dimensions of equipment and the positions of cable terminations.

12. Harmonic Filters

Where harmonics are generated by non-linear loads e.g. uninterruptable power supplies, variable speed drives, soft starters etc, or exist on the system, the project specification*** will state whether the power factor correction shall be provided by detuned or tuned harmonic filters instead of just by plain shunt capacitors.

The requirements for any or all of the following will be specified in the project specification:***

- Harmonic studies
- Harmonic filter designs
- Harmonic filter manufacture and installation.

E227 VOLTAGE TRANSFORMERS: (3,3 kV AND ABOVE)

1. Voltage transformers shall comply with SANS 60044-2 and shall be of the oil-immersed, air-insulated or encapsulated type, except when associated with air break, vacuum or SF6 circuit breaker when the oil-insulated type will not be permitted.

2. The normal ratio and rating shall be as specified in the project specification.***

3. The primary side of all voltage transformers shall be connected to the circuit through current limiting resistances and HRC fuses. It shall not be possible to gain access to these with the voltage transformer in service. The voltage transformers shall be of the plug-in type and shall be so arranged that they can be isolated and removed without affecting the associated circuits. The primary shall be connected to the busbar or cable side of the breaker as indicated on the drawings.***

4. When transformers are withdrawn, the plug connections on the switch panel shall be fully shrouded by means of automatic shutters. The shutters shall have padlocking facilities. It shall also be possible to lock the transformer in the 'service' position.

5. The secondary side of all voltage transformers shall be fused and one phase or the neutral, if it is available, shall be earthed. No fuses shall be fitted in a phase circuit that is connected to earth. On three-phase voltage transformers the neutral shall be brought out, and earthed. Care shall be taken to ensure that only the neutral or a phase, not both, is earthed.

6. Each group of voltage transformers shall be earthed directly to the earth bar by means of isolating links of the type where the link cannot be removed from the terminal. These links shall be readily accessible and safe with the voltage transformer racked out.

7. Voltage transformers shall be able to withstand the same surge voltages as the switchgear to which they are fitted.

8. Sufficient means shall be provided to prevent the paralleling of voltage transformers.

9. The burden of the voltage transformers shall be sufficient to drive all meters, relays, heaters and battery power supplies (if specified)***.

10. Class 1,0 voltage transformers shall be used, unless otherwise specified.

11. If remote metering is specified*** in the project specification then the voltage transformers shall also be wired to an easily accessible terminal block at the back of the appropriate panel.

E228 MEDIUM VOLTAGE PROTECTION AND RELAYS

1. GENERAL

1.1 Each circuit breaker and contactor shall be fitted with protection and auxiliary relays as specified on the drawings or project specification.***

1.2 Where the circuit breaker or contactor is to be equipped for remote indication and control, all the auxiliary relay switches shall be wired to an easily accessible terminal block on the back of each panel.

1.3 All measuring relays shall be supplied with built-in test facilities to enable secondary injection testing and measurement of currents, voltages, time delays and operating characteristics without disturbing any connections and without danger of opening CT circuits on load or causing false tripping. These test facilities shall be to approval. The supply of two test handles/plugs of each size and type shall form part of the contract.

Where the measuring relay does not have built-in test facilities, an equivalent separate front panel mounted test facility shall be provided for each measuring relay (or group of measuring relays where agreed by the Engineer). This protective relay test facility shall not be of the type where connections are made by open or short-circuiting link terminals and making screw clamped connections but of the type where connection of test equipment can be made by plugging in a test plug or handle.

1.4 Combined measuring protective relays shall be equipped with means to indicate whether the operation was due to phase overcurrent, earth fault, high-set instantaneous or inverse time. Where high set relays are provided with or combined with a time delay, the high set current relay operation shall only be indicated when the associated time delay has expired.

1.5 Where the MV bus is specified in the project specification*** to be provided with phase and earth fault busbar protection of the blocking type (whereby the detection by the incoming circuit of a fault condition will cause tripping of the busbar unless a relay on an outgoing circuit has also detected the fault and caused the incoming circuit relay's tripping impulse to be blocked), the overcurrent and earth-fault relays on the incoming and outgoing circuits shall be provided with fast current detector/starting outputs having current setting ranges to match, at least, the setting ranges of the delay overcurrent and earth fault relays.

1.6 Unless otherwise approved, all relays shall be of the flush, panel mounting draw-out type, and shall be clearly labelled to indicate their respective functions and shall be contained in dust-proof cases.

1.7 Relay terminal studs shall not be less than 5mm diameter, or, alternatively, relay connections shall be of an approved plug-in type.

1.8 Relays shall be with self-resetting targets. The targets shall not operate until the relay has closed its tripping contacts and resetting shall be accomplished without opening the case. The targets shall not be tripped by vibration caused by normal or fault operation of the associated circuit breakers.

1.9 Relay contacts shall be capable of repeatedly making and, where the circuit renders it necessary, repeatedly breaking, without deterioration, the maximum current possible in the circuit they control for at least the maximum duration of a fault as is set by the protective devices. Where more than one set of contacts is provided, all contacts shall operate simultaneously. Tripping contacts shall not close due to vibration engendered by the normal or the fault operation of the associated circuit breakers.

1.10 Unless otherwise specified, the relays shall be fitted with self-resetting contacts. Where hand reset relays are specified, resetting shall be accomplished without opening the case.
All hand reset relays shall be accessible to a person of normal height standing on the floor, unless otherwise approved.

1.11 The number of contacts provided on each relay shall be as specified in the schedule or drawings.*** Unless otherwise specified, contacts shall be available for external use and shall be individually wired. Hand or electrically reset relays shall be provided with an additional contact connected internally to interrupt the operating coil current. Electrical reset relays shall, in addition, if called for the provided with a contact connected internally to interrupt the resetting coil current. Electrical reset relays shall preferably also be fitted with hand resetting features. Make contacts shall be taken to mean contacts which are open when the relay is de-energised or reset. Break contacts shall be taken to mean contacts which are closed when the relay is de-energised or reset.

1.12 All trip relays and master trip relays shall be capacitor discharge proof, i.e. they shall not operate when a capacitor of 10 micro farad charged to 2 x EL dc (i.e. to 220V dc) is discharged through the operating coil.

1.13 Tripping duty contacts shall be capable of making and carrying 30A dc for 200ms in a circuit with a L/R of > 10ms.

Breaking duty contacts shall be capable of breaking the current of the associated controlled device on the specified breaking current in a circuit with a L/R of < 40 ms.

1.14 Where dc auxiliary supply voltages are specified, the supply for the relays comes from batteries. The battery voltage can vary about the nominal value to + 20% and - 20% and relays shall be capable of operating within these two limits. The relays shall also be capable of operating in the ambient temperature range of 0 - 55 degrees Celsius.

Where electronic or static relays are offered, these shall not malfunction if the dc auxiliary supplies are switched on or off or switched repeatedly at a random rate.

1.15 Trip indicators for Buchholz and temperature trip indication shall preferably be of the current operated type and each element shall have a coil with pick-up currents and rating to match the current of the associated tripping circuits, whether relay or breaker, down to 50% or nominal battery voltage.

1.16 Where the circuit breaker is to be equipped for remote indication and control, all the relay auxiliary switches shall be wired to an easily accessible terminal block on the back of each panel.

1.17 Allowance shall be made for additional terminal blocks on every panel for testing purposes if solid state relays are offered. Combined solid state overcurrent and earth fault relays shall be equipped with indicating flags or lamps showing the nature of the fault.

2. ELECTRONIC EQUIPMENT

2.1 When electronic equipment is mounted on racks these shall be the standard 19 inch type, fitted with cubicle surrounds with lockable doors and provided with adequate ventilation.
Electronic schemes shall be supplied with power supplies which shall be capable of operating over the dc voltage and temperature ranges specified above.

Particular attention shall be paid to the accessibility of components for maintenance and testing. All printed circuit cards shall be fully withdrawable and print extenders or adapters shall be provided to facilitate testing.

2.2 Equipment requiring built-in batteries will not be acceptable unless otherwise approved in writing by the Engineer.

2.3 All semi-conductor devices shall be of the silicon type.

2.4 DC/DC converters or approved equivalent means shall be provided to furnish the power supplies required for static relays. These shall provide galvanic isolation and protection against induced voltage surges of longitudinal or transverse mode. They shall operate over the specified + - 20% of nominal voltage and be provided with healthy output indication and remote alarm facilities in the event of supply failure. The converters shall be short circuit proof.

2.5 Static relays shall comply with the test requirements if IEC 255-4 as follows:

Insulation Test Voltage:

2 kV, 50 Hz, 60 sec.

Impulse Test
5 kV, 1,2/50 us, 0,5 joule (according to Appendix E)

High Frequency Disturbance Test:

Common mode 2,5 kV, 1 MHz/Transverse mode 1 kV, 1 MHz (according to Appendix E)

Fast Transient Test:

Fast transient (showering arc) test SEN36. 15.3 with a peak value of 4-8 kV.

2.6 Diodes:

Where blocking diodes are required for the operation of the circuit, these shall be of the silicon avalanche type having a rated PIV of 800 volts minimum. They shall have a continuous current rating to match the maximum current which they will be required to carry in service.

3. INVERSE-TIME AND INSTANTANEOUS OVERCURRENT

3.1 The relays shall be provided with three ac overcurrent elements (51) having at least:

a) Standard inverse time characteristic to BS142.

b) Very inverse time characteristic.

c) Extremely inverse time characteristic.

The current plug setting range shall be 50 - 200% of relay rated current.

The overshoot at 20 x setting shall be less than 40 ms (Standard inverse relay) or 65 ms (very inverse and extremely inverse relays). The resetting current shall be greater than 90% of the setting.

A set of N/O (make) contacts wired out of separate terminals shall be provided.

3.2 The relay shall also be provided with three high set instantaneous overcurrent elements fitted with a set of N/O (make) contacts wired out to separate terminals.

The settings range shall be 400 - 1600% of relay rated current and the transient over reach factor shall be less than 120%.

3.3 Each inverse element and each instantaneous element shall be provided with a hand reset operation indicator.

3.4 The relay current circuit thermal rating shall be at least twice the setting current continuously and 20 x the maximum setting current for 3 seconds.

3.5 All relay tripping contacts shall be capable of making and carrying 30A dc for 200ms in a circuit with L/R > 10ms.

Where the measuring relay contacts are not capable of this duty, separate high speed self-resetting tripping relays shall be provided.

4. INVERSE TIME EARTH FAULT

4.1 The relays shall be provided with three ac over-current elements having at least:

a) Standard inverse time characteristic to BS142.
b) Very inverse time characteristic.
c) Extremely inverse time characteristic.

4.2 The current plug setting range shall be 20 - 80% of relay rated current.

4.3 The overshoot at 20 x setting shall be less than 40ms (Standard curve) or 65ms (extremely inverse curve).

4.4 A hand reset operation indicator and a set of N/O (make) tripping duty contacts wired out to separate terminals shall be provided

4.5 The current circuit thermal rating shall be 20 x the maximum setting for 3 seconds.

5. TRIP SUPERVISION RELAYS

5.1 These shall be suitable for supervising the trip circuit of circuit breakers or latched contactors with the circuit breaker or contactor open or closed. The relays shall be delayed on drop-off by 100 – 400 ms to prevent spurious operation during breaker operation or during clearing of the dc faults.

5.2 Resistors shall be provided to ensure no tripping will occur if the relays are accidentally short circuited.

5.3 The relay burdens shall be kept to a minimum to prevent excessive drain on the tripping and alarm batteries.

5.4 Normally this trip supervision consists of 3 relays A, B and C where relay C is a repeat relay for A and B. Relay C shall be wired to separate terminals so that it can be connected to a supply independent of that for A and B. The operation indicator shall be hand reset.

The relay shall be fitted with two normally open N/O (make) contacts and one normally closed N/C (break) contact, self-reset, and wired to separate terminals.

6. SELF-RESET TRIPPING RELAYS

6.1 These shall be self-reset relays fitted with at least two normally open tripping duty contacts separately wired out, and a hand reset flag indicator. The relay operating time shall be of the order of <10ms at rated voltage.

6.2 The relays shall be capable of operation down to 53% of rated voltage and shall be of the high burden type capable of withstanding the capacitor discharge test.

7. HAND RESET MASTER TRIPPING RELAYS

7.1 These shall be similar to Clause 6 above but the contacts and flag shall be hand reset. The relay shall be fitted with an internal coil cut-off contact and 3 N/O and 1 N/C (external) contacts. All contacts shall be wired to separate terminals.

7.2 The relays shall be provided with an obvious operation indicator or a separate flag indicator.

8. AC UNDERVOLTAGE RELAYS

8.1 These shall be definite time delayed relays having a drop-out of 60 - 90% nominal voltage rating and a pick-up/drop-out ratio not exceeding 105%.

8.2 The time delay shall be adjustable over the range 0,5 - 3 seconds. Two self-reset normally open N/O (make) contacts wired out to separate terminals are required together with a hand reset flag indicator which operates only on expiry of the set time delay. The relay shall preferably operate in the "fail-safe" mode, unless otherwise specified, i.e. loss of ac or auxiliary dc shall result in tripping of the associated breaker or contactor.

9. DEFINITE TIME DELAY RELAYS

9.1 These shall preferably be or the high precision static type with time delay adjustable over the range 0,01 - 9,99 seconds in 0,01 second increments.

9.2 The accuracy at nominal voltage shall be of the order of + - 5% of setting or + - 10ms whichever is the greater, over an ambient temperature range of 10 - 30 degrees Celsius.

9.3 The repeatability shall be within + - 1% or + - 10ms, whichever is the greater, assuming the relay resets completely between successive operations.

9.4 The relays shall be fitted with two self-reset normally open N/O (make) tripping duty contacts and a hand reset flag indicator.

10. INFORMATION WITH THE TENDER

The following information concerning the relays shall be submitted with the tender:

10.1 Complete descriptive information in English or Afrikaans explaining the operation of the relays for internal and external fault and the methods for determining the required settings.

10.2 Circuit diagrams of relays.

10.3 Outline dimensions of relays.

10.4 Schematic diagrams of overall protection schemes.

10.5 Outline dimensions of cubicles.

10.6 Detailed block diagrams for printed circuits in the case of electronic relays.

E229 3,3 kV TO 33 kV SWITCHGEAR (CIRCUIT BREAKERS)

1. GENERAL

1.1 The Contractor shall supply and install high voltage switchgear as specified in the Project Specification and indicated on the drawings.

1.2 Type of Switchgear

Contractors may offer minimum or bulk oil or SF6 or vacuum type circuit breakers unless otherwise specified*** in the Project Specification. All circuit breakers shall be trip-free, horizontal or vertical isolating, horizontal draw out type. Full details of circuit breakers offered shall be submitted with tenders.

1.3 Characteristics of Switchgear

1)	Number of poles	:	3
2)	Type	:	Indoor
3)	Rated voltage	:	The switchgear shall be suitable for the rated voltage and system conditions as set out in the Project Specification.***
4)	Rated impulse withstand	:	As specified in the Project Specification.***

5) Rated frequency : 50 Hz

6) Fault rating : The fault rating of switchgear shall be one of the following as set out in the Project Specification***: 8 kA, 12,5 kA (or 13,1 kA*) 20 kA (or 18,4 kA*) or 25 kA.

*These ratings are acceptable unless otherwise specified.

7) Duration of short circuit : 3 seconds.

8) Phase rotation : Anti-clockwise, Red-Yellow-Blue-Red, unless otherwise specified.***

1.4 Busbars

Single or double set of busbars shall be used as set out in the Project Specification***. All busbars shall be insulated, including busbar joints and T-off points.

1.5 Auxiliary Switches

1) If the equipment is to be suitable for remote indication, as set out in the project specification***, then auxiliary switches shall be provided to give the status of the circuit breaker, isolator and spring.
For double busbar switchgear, auxiliary switches are required to give the positions of each circuit breaker relative to each set of busbars.

2) Over and above the number of auxiliary switches specified above, provision shall be made for additional auxiliary switches for the interlocking as specified in the Project Specification***.

3) In addition to the number of auxiliary switches specified in (1) and (2) above, two normally open and two normally closed spare auxiliary switches shall be provided for each circuit breaker and isolator.

4) All the auxiliary switches on each panel shall be wired to an easily accessible terminal block at the back of each panel.

1.6 Instrumentation and Lamp Indication *(Refer also to Clauses E213 and E215)*

1) Metering instruments shall conform to the requirements specified herein. Metering instruments and lamp indication shall be provided as set out in the project specification*** and indicated on the drawings.

2) Where indicating lamps are supplied from the batteries, they shall be separately wired from the mechanism and tripping circuits to an easily accessible terminal block at the back of a panel.

1.7 Oil or SF6

The price for the supply and delivery of switchgear shall include the supply, delivery and filling of suitable and sufficient oil or SF6 gas, where applicable.

Prior to acceptance the Contractor shall prove at his own cost that the switchgear is sufficiently filled and that the oil or SF6 gas complies with the specified standards.

1.8 Cable End Boxes, Clamps and Terminations *(Refer to Clause E212)*

1) The switchgear riser terminals shall be properly tinned.

1.9 Earthing Arrangement

1) Each circuit breaker and isolator shall be so constructed that it is possible to earth the cables.

2) It shall not be possible to earth the busbars under any circumstances.

3) The complete switchboard shall be provided with a continuous copper earth bar at the back of the panels.

1.10 Labelling *(See Clause E214)*

1.11 Anti-condensation Heaters

1) 30 W, 230 V Anti-condensation heaters shall be provided and installed in the busbar and current transformer chambers, unless otherwise specified.

2) The heaters shall be controlled from an "ON/OFF" switch installed on one of the panels - preferably the bus-coupler panel.

3) The heaters shall be supplied from the voltage transformer or an external supply if no voltage transformer is specified or the voltage transformer is fully loaded. Where an external supply is to be used, the heaters shall be suitably wired to a terminal block at the back of each panel.

1.12 Panel Wiring and Terminal Blocks *(See Clauses E209 and E210)*

1) Unless otherwise specified or approved, no fuses shall be installed in any tripping circuits, but holder-mounted links shall be provided instead.

1.13 Cable Trench Checker Plate Supports

When the design of the switchgear is such that the gear has to overhang the cable trench, switchgear manufacturers shall fit suitable, adjustable treated angle iron brackets to the bottom frame at the rear of switchgear to support the checker or asbestos plates of substation cable trenches. Where frame leakage protection is specified these angle irons shall be treated with PVC sheath to isolate the checker plates from the switchgear.

1.14 Tools

1) If the design of switchgear is such that integral earthing of cables is not possible, then suitable earthing equipment shall be provided for each type of circuit breaker and isolator for each substation.

2) Suitable testing prongs and jumpers shall be provided for the switchgear for each substation where the design of switchgear requires such equipment.

3) At least two spring charging handles, operating handles and switchgear door keys (where applicable) shall be provided for each substation.

4) Wall-mounted brackets shall be provided at each substation for carrying the manual operating handles and test jumpers.

5) If special tools are required, a complete set of finished case-hardened spanners and special wrenches to fit every nut and bolt on the equipment supplied, shall be provided under this contract at each substation. Any special tools or keys that may be required for effecting adjustments of parts, as well as all standard earthing and test equipment, shall also be provided at each substation.

6) These tools shall be accommodated in a suitable, neat, properly designed, wall constructed steel equipment board with the tool positions marked at each substation. The board shall be capable of being locked by means of a padlock.

7) A fully detailed list of tools shall be supplied before delivery.

8) The tools shall not be used for the erection of the contract works.

1.15 Spare Fuses
Switchgear shall be provided with spring assisted hand operated **and Lamps _(See Clauses E205 and E213)_**

2. CIRCUIT BREAKERS

2.1 Operating Mechanisms

1) 8 kA mechanisms or any other standard mechanisms approved by the Engineer.

2) Other circuit breakers can be provided with spring operated mechanisms with hand or motor spring charging, or solenoid mechanisms as set out in the project specification***.

3) Spring and solenoid operated switchgear shall be provided with electrical control switches on the instrument panels for local closing and tripping if specified in the project specification***. The control switches shall be spring returned to the neutral position and shall be so designed that after having once been moved to the "close" position, they cannot again be moved to the "close" position, without first having been moved to the "open" position.

   An approved method for locking the control switches in the neutral positions shall be provided.

4) If the above-mentioned control switches are not required, then the circuit breakers shall be fitted with an electrical tripping push button mounted on the front of the instrument panel.

5) If motor wound spring mechanisms and/or solenoid mechanisms are offered, then the Contractor shall ensure that suitable batteries with sufficient capacities are provided to supply the motors and/or solenoids respectively.

6) If remote operations of circuit breakers are specified in the project specification***, then each breaker shall be provided with a "LOCAL/REMOTE" selector switch mounted on the instrument panel. In such a case, all the wiring for remote operation shall be wired to an easily accessible terminal block at the back of each breaker.

2.2 Trip Coils

Each circuit breaker shall be provided with trip coils, suitable for the battery trip circuit voltage, to be operated by the relays as specified.

2.3 Current Transformers (See Clause E207)

2.4 Voltage Transformers (See Clause E227)

2.5 Mechanical Interlocks and Safety Shutters

The following minimum interlocks are required:-

1) It shall be impossible to raise, lower or withdraw the circuit breaker unless tripped.

2) It shall be impossible to close the circuit breaker unless it is either fully plugged-in, fully withdrawn or earthed.

3) It shall be impossible to plug in the circuit breaker or to close it unless the tank is properly secured.

4) When the breaker is withdrawn, the cubicle contacts shall automatically be covered by substantial vermin-proof shutters. Shutters shall be provided with means of padlocking in the closed position.

5) In instances where the control and protection circuits are connected by multicore cable and a plug to the circuit breaker mechanism contacts, additional interlocking will be required to prevent the circuit breaker being closed in the operating position without the protection circuits being connected.

6) All safety shutters shall be clearly and indelibly labelled in letters of the largest possible size, indicating the live apparatus screened off by the shutters.

2.6 Relays (See Clause E228)

3. ISOLATORS (See Clause E225)

4. MULTICORE AND AUXILIARY CABLE CONNECTIONS

The following circuits shall be wired to a terminal block at the back of the panels:-

a) DC Tripping and control circuits.

b) DC Standing load circuits.

c) 230 V AC Circuits for heaters, and other 230V equipment to be supplied from an external source.

d) Other circuits for remote control and remote metering as previously specified.

Contractors shall further allow for external wiring to the panels as follows:-

a) DC Tripping and control supply to the battery charger unit.

b) DC Standing load supply to the battery charger unit.
c) 230 V AC Supply from the building distribution board.

d) All Solkor and other pilot wire protection schemes to a pilot cable termination box.

e) All other circuits required for remote control and supervisory functions to a multicore cable termination box, if specified.

f) All cabling shall be correctly rated and properly marked.

5. INSTALLATION AND ERECTION

5.1 Fixing Drawings

The successful Contractor shall submit a manufacturer's detail drawing with dimensions indicating fixing holes and positions of the switchgear, to the Engineer within 10 days after the appointment, to enable the builder to place the unistruts for fixing the switchgear in the correct position.

5.2 Alignment and Fixing of Switchgear

1) The switchgear panels shall be properly aligned, erected, plumbed, bolted together and fixed onto the floor.

2) If the floor is not level, suitable non-perishable packing material shall be used to level the switchboard.

3) Each individual panel shall be levelled before the panels are bolted together.

4) The panels shall be assembled and erected strictly in accordance with the manufacturer's instructions, which shall be issued to the Installation Contractor by the manufacturer.

5) Switchgear trucks shall move freely and shall be properly aligned.

6) If frame leakage protection is specified, the switchgear shall be erected in such a manner that it is fully insulated from the floor and any earth.

5.3 Cabling

1) All paper insulated cables shall be wiped unless the use of heat-shrink type terminations are approved by the Engineer. A stranded copper earth conductor shall be wiped into the cable end wipes.

2) Cross-linked polyethylene cables shall be made off with suitable terminating kits recommended by the cable manufacturer and approved by the Engineer. These cables shall be properly clamped with wooden blocks fixed to the switchgear.

3) Suitable wooden blocks shall be fixed to the wall of the cable duct to support all cables from 95 mm^2 and larger.

4) The switchgear and all cable earth conductors shall be correctly earthed to the substation earthing system.

5) Low voltage and pilot cables shall be properly made off by using glands and shall be supported and terminated where required.

6) All entrances to the panel shall be vermin-proofed.

5.4 Tool Boxes and Brackets

All tool boxes and testing equipment brackets shall be properly fitted against substation walls in suitable positions.

5.5 Fuses and Lamps for Commissioning

The Contractor shall not use the spare fuses and lamps for the commissioning of the switchboards.

5.6 Cable Duct Cover Plates

The Installation Contractor shall cut the duct cover plates to the correct size and shape. All cut edges shall be repainted, whereafter the cover plates shall be replaced.

5.7 Earthing

Each installation shall be correctly connected to the substation earth bar by means of a 70 mm^2 stranded copper conductor or 30mm x 3mm copper bar, at a minimum of two points.

E231 MEDIUM VOLTAGE (UP TO 33 kV), LOW VOLTAGE AND PILOT CABLES

1. General

1.1 The Contractor shall supply and install cables as specified in the Project Specification*** and indicated on the drawings.

2. Cable Construction

2.1 Medium Voltage Cables

2.1.1 <u>Paper-insulated Cables</u>

1) Heavy duty, mass-impregnated, belted, non-draining, paper-insulated, lead-covered, steel wire armoured, unearthed, stranded 3-core cables, shall be supplied, which shall conform to the latest issue of SANS 97. If steel tape armouring and/or screened cables are preferred, it will be specified*** in the project specification.

2) Cables shall have an outer serving of PVC, unless otherwise specified.

3) Anti-electrolytic cables, where called for, shall finally be served with PVC. The following information shall be printed on the outer PVC sheath, in the factory, where possible:-

Voltage, e.g.	:	11 kV
Size, e.g.	:	185 Cu or 185 A1.
Name of Client	:	If required in Project Specification***

The abovementioned information shall be printed on the cable at reasonable intervals.

4) The cores of cables shall be stranded copper or aluminium conductors as specified or as alternatively offered.

2.1.2 <u>Cross-linked Polyethylene Cables</u>

1) Cross-linked polyethylene (XLPE), 3 core, steel wire armoured or unarmoured cables of an approved manufacture shall be used when specified***, provided that full technical information is submitted with the tender. All XLPE insulated cables offered shall comply with SANS 1339. Cores shall be individually screened.

2) The type of cable required shall be specified in the Project Specification.***

3) The following information shall be printed on the outer PVC sheath, in the factory, where possible:-

Voltage, e.g.	:	11 kV
Size, e.g.	:	185 Cu or 185 A1.
Name of Client	:	If required in Project Specification***

The abovementioned information shall be printed on the cable at reasonable intervals

2.2 Low Voltage Cables (1000 V)

2.2.1 <u>Cables</u>

1) All low voltage cables shall be polyvinyl chloride insulated with steel wire armouring or strip aluminium armouring, as specified***, and served overall with a final layer of polyvinyl chloride.

2) Cables shall be round with the number of cores specified and suitable for general service as prescribed in SANS 1507.

3) The cores shall be stranded copper or solid shaped aluminium.

4) The cables with stranded copper cores shall be armoured with single steel wire armouring, unless otherwise specified.

5) The cables with solid aluminium cores shall be armoured with strip aluminium armouring or steel wire armouring as specified.

6) Cables with tinned copper earth continuity conductors as part of the armouring shall only be provided when specified*** in the project specification.

2.3 Pilot Cables

2.3.1 <u>Specification and Core Sizes</u>

Pilot cables shall comply with the applicable SANS.

Pilot cable cores shall be 0,9 mm diameter unless otherwise specified.

2.3.2 <u>Working Conditions</u>

The pilot cables may be installed in the same trenches as low voltage or high voltage power cables at depths varying between 0,8 and 1,5 m. Pilot cables may also be installed directly underneath and parallel with overhead power lines.

Pilot cables shall be used for protection applications, as well as speech and data communications.

2.3.3 Electrical Requirements

1)	Continuous working voltage	:	250 V, 50 Hz between cores
2)	Maximum loop resistance	:	56 ohm/km
3)	Minimum insulation resistance	:	30 000 megaohm/km
4)	Mutual capacitance of pair	:	60 nanofarad/km maximum at 800Hz
5)	Capacitance unbalanced	:	600 pF/km maximum at 800Hz
6)	Overvoltage withstand capabilities	:	5 kV between any two cores; 10 kV between any core and any metal work that may be earthed
7)	General	:	Pilot cables shall be designed to ensure the minimum cross-talk level and maximum immunity against induced effects

2.3.4 Mechanical Requirements

1) Unless otherwise specified, pilot cables for outdoor use shall be petroleum-jelly filled. Contractors may offer cables with a polyethylene/ aluminium laminated sheath as alternative for consideration by the Engineer.

   All pilot cables shall in any case be fully waterproof, even when operating for extended periods of time fully submerged in water or waterlogged soil.

2) Cable insulation shall be polyethylene.

3) Bedding layers shall be polyethylene.

4) Galvanized steel wire armouring shall be provided.

5) The outer sheath of the cable shall be PVC and an overall conductive coating of colloidal graphite or other conductive material shall be applied to the serving to facilitate voltage testing to earth.

6) All cores shall be clearly and indelibly identified by means of numbers or a colour code.

7) Contractors may offer alternative cables, but full constructional detail shall be submitted with tenders.

2.3.5 Tests and Inspections

1) All pilot cables offered shall in all respects comply with applicable international and/or Telkom Specifications.

2) Tender prices shall include for the costs of performing the following tests on each drum of cable:-

   a) Conductor resistance test

   b) Overvoltage tests

   c) Capacitive tests

3) The Engineer shall be notified at least two weeks in advance of when such tests are to be performed. The Engineer reserves the right to witness all such tests.

4) Test certificates of all tests shall be submitted to the Engineer prior to or with the delivery of the cables.

2.3.6 <u>Pilot Cable Terminal Boxes</u>

1) The multicore cables shall be connected to the panels and equipment via terminal strips in terminal boxes in all substations when specified in the project specification***.

2) The Contractor shall allow for the supply and installation of centrally situated, wallmounted terminal boxes when applicable.

3) The terminal boxes shall be manufactured from mild steel of minimum thickness of 2 mm. A steel frame shall be used to ensure rigidity where necessary. The terminal boxes shall be fitted with front opening hinged lockable doors.

4) All doors shall be of a neat dustproof fit, and the enclosures shall be completely verminproof.

5) The terminal boxes shall be adequately ventilated for the prevention of condensation.

6) The terminal boxes shall be wall mounted.

7) The terminal strips inside the terminal box shall comply with the standard specification.

8) Terminal blocks shall have separate terminals for incoming and outgoing wires, and not more than two wires shall be connected to any one terminal. Insulating barriers shall be provided between adjacent pairs of terminals. The height of the barriers and the spacing of the terminals shall be such as to give adequate protection while allowing easy access to terminals. The connections shall be suitable for the cables provided.

3. Excavations and Laying of Cables

3.1 General

1) 11 kV Cables, low voltage cables, pilot cables, telecommunication cables and pipes shall be laid in the same trenches, where applicable, and in the positions as shown on the drawings.

   The rates for the laying of cables shall include for the laying of cables over or under other services.

2) The spacing between cables shall be exactly as shown on the drawings. The positions of cables shall always be measured from boundary lines of stands, unless otherwise specified.

3) After all cables have been laid and correctly spaced, they shall be inspected and approved by the Engineer before trenches are backfilled. In the event of the Contractor not notifying the Engineer well in advance of an inspection, the Contractor shall then open sections of the trenches for inspection at his own cost.

4) The tender prices for excavations shall include the following:-

   a) Excavations of cable trenches.

   b) Levelling of the bottom of trenches.

   c) Supply and laying of a 75 mm minimum layer of sifted soil.

   d) Supplying and covering of the cables with a 75 mm layer of sifted soil after the cables have been laid and spaced and after the inspection and approval by the Engineer.

   e) The backfilling and consolidation of trenches with soft soil.

   f) The removal of all surplus materials from the sites.

   g) Finishing and levelling of sites where excavations were done.

5) Cables shall be drawn off drums in the same direction where more than one drum is involved in a cable laying route. The drums shall be suitably placed along the cable route. All drums shall be rolled as indicated by the arrows marked on the drums.

6) No crossing of cores shall be permitted in cable boxes.

7) The quantities of cable trench excavations as set out in the Schedules of Quantities are estimated quantities. The Contractor will be paid according to the actual quantities as measured on site after the cable trenches have been excavated, measured, the cables laid and the trenches backfilled.

8) All cable trenches and especially road crossings shall be properly consolidated. All road surfaces shall be reinstated to the original condition, unless otherwise specified.

9) The widths of cable trenches which will be used for the purpose of measurements, where applicable, will be determined by the combination of the number of cables and/or pipes as specified in the Project Specification and as shown on the drawings.

3.2 Trench Preparation

Once the trench has been basically excavated, trimmed and levelled, the bed of the trench shall receive the following treatment:-

3.2.1 Trenching in Hand-Pickable Ground

1) The bed of the trench shall be checked for the presence of loose rocks or sharp objects. All loose foreign materials shall be removed, leaving the bed of the trench clear.

2) The cleared bed of the trench shall be lined with a layer of backfill screened through a 4 mm mesh, to a depth of 75 mm.

   The bed of the trench shall be levelled in a manner which will prevent the cable riding high at any point along its installation. River sand or mine dump scrap will not be accepted as cable trench bedding.

3.2.2 Trenching in Ground requiring Rock-Breaking or Blasting

Where the cable trench has to be cut through ground requiring compressor drilling, rock breaking and/or blasting, the bottom screened soil backfill shall be laid so that 100 mm of screened backfill covers rocky protrusions. All jagged edges of rock, and foreign materials such as loose rocks and sharp objects shall be removed so as to present no risk of subsequent damage to the cable.

3.2.3 Trench Backfilling

1) Upon completion of the cable laying, the cable shall be covered with a layer of 75 mm of backfill screened through a 4 mm mesh.

2) Subsequent backfilling, above the 75 mm layer mentioned above, shall be screened through a 40 mm mesh.

3) Cable protective slabs (only if specified) shall be placed over a minimum backfill of 75 mm above the cables.

4) Excavated ground backfill shall follow upon Item 2 above, the backfill being consolidated at 300 mm levels. The backfill shall be consolidated to at least the same compaction of the original surrounding soil, but to the satisfaction of the Engineer.

   Backfilling and consolidation shall be in accordance with SANS 1200.

5) The backfilled trench shall be domed so as to provide drainage, the dome being 150 mm above the surrounding ground level.

3.3 Road and Railway Crossings

3.3.1 General

The Contractor shall allow in his price for the complete installation of the road and railway crossings as indicated on the drawings.

1) The crossing installations shall be in accordance with the detail drawings included in the contract.

2) All excavations, unless otherwise specified in the tender documents, shall be constructed at right angles to the roads and/or railway servitudes.

3) Rigid PVC or asbestos cement pipes shall be used for the crossings. The pipes shall be properly joined. The open ends of spare pipes shall be sealed with easily removable caps or plugs.

4) All crossings, their construction and implementation, shall be carried out in accordance with the requirements laid down by the Local Authorities, the Provincial Roads Department, and the Department of Transport, the Transnet and others.

5) The rates for the laying of cables shall include the pulling through of cables through sleeve pipes in road crossings.

3.3.2 Road Crossings

1) Excavations across roads shall be carried out with the minimum inconvenience to the public and the authorities.

2) Excavations across main roads where the width of the road between kerbs is 9 meters or more, shall be carried out in half road widths so that the flow of traffic can be maintained.

3) Where tarred road surfaces are cut, such cuts shall be neat and straight and no jagged edges shall be tolerated.

4) Road crossings in townships shall always be opposite a stand boundary peg unless otherwise shown.

5) The excavations shall be of such depth that the dimension from the top of pipe ducts to the road surfaces shall not be less than 1.2 m, or as otherwise specified on detailed drawings.

6) The Contractor shall be responsible for the provision of road warning signs, road barriers, the stringing of danger tapes and the positioning of warning lamps between sunset and sunrise. Flashing type warning lamps shall also be positioned at strategic points in the construction areas to caution motor vehicle traffic.

3.3.3 Cable Pipe Ducts

1) Concrete, asbestos cement, polyethylene or PVC pipes shall be used for cable pipe ducts which shall comply with the relevant SANS specification. Suitable approved joints shall be used for the pipes.

2) The cable pipe ducts shall protrude not less than 750mm and not more than 1 000 mm on either side of the street kerbing.

3) The pipe ducts shall be neatly trimmed at the ends after laying, and a heat-shrinkable duct end cap shall be fitted over each and every open end through which no cable is installed. Where the size of the duct does not permit the fitting of these covers, then the open ends shall be sealed by means of a weak cement mix of 7 sand to 1 cement. Polystyrene plugs of suitable size may also be used.

4) All pipe ducts shall be fitted with galvanized steel draw wires.

5) The ducts shall be laid as shown on the enclosed drawings, the required depths and distances between duct centre lines being shown.

3.3.4 Trench Backfilling and Compaction

1) Only material which is compactable shall be used for the backfilling of road crossing excavations. At the discretion of the Engineer, suitable soil shall be imported for the backfill material. No rocks shall be included in the backfill.

2) The backfilling shall be carried out in 150 mm layers (after compaction), each layer being compacted by means of a compacting machine. Each layer so backfilled shall have a sufficient moisture content to ensure that solid binding of the material is obtained. The backfill shall be compacted to modified AASHTO as specified in SANS 1200.

3) Tar re-instatement shall be carried out within four days of completing the trench backfilling. At this stage, the trench excavation shall be trimmed so as to permit the full thickness of tar re-instatement.

3.3.5 Railway Crossings

1) Crossings of railway tracks shall be carried out in accordance with the latest requirements as set out in the approvals received from the South African Transport Services (Transnet) and the requirements of SANS 15589 for cathodic protection of buried and submerged pipelines.

2) Railway crossings shall comply with the detail drawings issued in regard to main dimensions and installation details.

3) The installation Contractor shall fully familiarise himself with the railway's operational procedure, and the necessary forward planning shall be carried out by him for the safe execution of the work.

3.3.6 Types of Crossings and Duct Sizes

The crossings consist of the following:-

1)	High voltage cable crossings	:	The cables shall be laid in 150 mm dia. pipes. One spare pipe shall be installed for each high voltage cable, unless otherwise specified.
2)	Low voltage cable crossing	:	The main low voltage cables and street-light cables shall be laid in 100 mm dia. pipes. No spare pipes are required for low voltage cables.
3)	Low voltage service connection cable crossings	:	These are crossings between minisubs or cubicles on the one side of the road reserve to low voltage connection boxes or service connection on the opposite side of the road reserve. More than one cable

can be laid in the same 100 mm dia. pipes. No spare pipes are required. These pipes shall be installed from the cable reserve on one side of the road reserve to the cable reserve on the opposite side of the road reserve with the ends of the pipe 0,5 m from the stand boundaries.

4) Special crossings : Cable crossings below motor highways and wide railway reserves are special cases and will be specified separately.

3.4 Classification of Excavations

3.4.1 Tenders shall submit rates for excavations in the following soil types

1) <u>Excavations in Soft Materials</u>

Excavations which can, in the opinion of the Engineer, be carried out by pick and shovel or a machine shall be considered as excavations in soft material. The classification definition for "soft excavations" and "intermediate excavations" as set out in SANS 1200, are combined in this specification document as "excavations in soft materials".

2) <u>Hard Rock Excavations</u>

Excavations in formations that require blasting or wedging and splitting, will be classified as hard rock excavations. The rates shall include the removal of rock from site.

3) <u>Boulder Excavations, Class "A"</u>

Excavations in material containing by volume more than 40% boulders ranging in size from 0,03 m^3 to 2,0 m^3 in a matrix of soft material, will be classified as boulder excavations, Class "A". The rates shall include the removal of rock from site.

4) <u>Boulder Excavations, Class "B"</u>

Excavations in material containing by volume 40% or less boulders ranging in size from 0,03 m^3 to 2,0 m^3 in a matrix of soft material, will be classified as boulder excavations, Class "B". The rates shall include the removal of rock from site.

3.4.2 The excavations will be measured as set out in SANS 1200. Excavations in soft materials will be measured on a linear basis.

The measurement for the following excavations will be on a volumetric basis and it will be considered as an extra over rate:-

1. Hard rock excavations

2. Boulder excavations, Class "A"

3) Boulder excavations, Class "B"

3.4.3 The Engineer's decision as to the type of excavations excavated shall be final and binding, and the Contractor shall be paid in accordance with the classification by the Engineer.

3.4.4 Jointing Pits

The Contractor shall provide workable jointing pits where cables are to be jointed. The costs of jointing pits are to be included in the normal excavation rates of cable trenches.

3.5 Cable Trench Layout

The standard minimum cable trench depths are as follows unless otherwise specified:-

1)	11 kV Cables only, or 11 kV plus LV cables	:	1,0 m deep
2)	Pipes for cables underneath road surfaces	:	2 m to top of pipe measured from lowest point of final road surface
3)	LV cables and streetlight cables	:	800 mm deep
4)	Cables through premises and property		
	a) 11 kV only, or 11 kV plus LV or LV Main Cables	:	1 000 mm deep plus slabs
	b) Service connection cables	:	800 mm deep without slabs

The widths of cable trenches which will be used for the purpose of measurements, where applicable, are determined by the combination of the number of cables and/or pipes as specified in the Project Specification and as shown on the drawings.

3.6 Cables in Servitudes inside Stands

The Contractor shall conform to the following requirements where cables are laid in servitudes inside stands:-

1) The cable trenches shall be 1,0 m deep or as specified and as close as possible to the stand boundary, but inside the servitude.

2) The cable shall be laid on a 75 mm bedding of sifted soil.

3) The cable shall be covered with a 75 mm layer of sifted soil.

4) Concrete slabs shall be laid above the cable on top of the sifted soil covering mentioned in Item (3) above, for the full length of the stand. PVC marker tape shall be laid on top of the concrete slabs.

5) The trench shall be back-filled and consolidated as previously specified, and the site shall be levelled. All surplus materials shall be removed.

6) The costs of the concrete slabs shall be included in the prices for the laying of cables unless separate pricing is requested.

3.7 Cable Crossings

1) Where power cables cross communication cables and/or pipes and vice versa, the crossings shall be done in accordance with the requirements of Telkom. The power cables shall be laid underneath the communication cables and concrete slabs shall be laid above the power cables to separate the power and telecommunication cables.

2) Where power cables cross each other the cables shall not be laid directly on top of each other but shall be separated with a 100mm layer of sifted soil. Where the cables cross, they shall not be bent with less than the minimum allowable radius.

3) After completion of the work the Contractor shall certify in writing that he complied with all the requirements specified by the authorities.

4. Land Surveyor Pegs

4.1 Stand boundary pegs which were installed by the Land Surveyor shall under no circumstances be removed or shifted.

4.2 Any stand boundary pegs which are found missing by the Contractor during the execution of his contract works, shall immediately be reported to the Engineer. If the Contractor does not report missing stand pegs when cables are laid and the cables are laid in wrong positions, then the Contractor shall re-lay the cables at his own cost.

4.3 The Contractor shall immediately notify the Engineer if any pegs are removed or shifted by the Contractor. In such cases these pegs shall not be reinstated by the Contractor.

4.4 The pegs will be reinstated by a Land Surveyor at the cost of the Contractor.

4.5 On completion of the contract the Contractor shall provide a Land Surveyor certificate to the effect that all pegs along the routes where the Contractor had worked are intact. For this reason Contractors are advised to ensure that all pegs are in position when taking over the site unless otherwise approved by the Engineer.

5. Bush Clearing

The absolute minimum number of bushes and trees shall be cleared by the Contractor for the purpose of laying cables.

6. Cable Markers

6.1 Marking Tape

Yellow PVC marking tape, 150 mm wide, with the wording "Buried Electric Cable - Caution" in both English and Afrikaans, printed in red or black, shall be laid approximately 300 mm below ground level above the high voltage cables. One marking tape shall be laid for every two high voltage cables installed.

6.2 Cable Markers

Cable markers shall be installed if specified*** in the Project Specification. Cable markers shall be approved by the Engineer prior to installation.

7. Damages to Fences, Walls, Street Surfaces, Kerb Stones and Properties

7.1 Before the Installation Contractor commences with any excavation work, he shall submit a detailed list of all existing damages to fences, walls, street surfaces, kerb stones, properties, etc. to the Engineer who will inspect and verify the list.

7.2 After the completion of all backfilling and compaction of cable trenches, the Installation Contractor may request an inspection to have all the damages brought about by his operations listed and verified by the Engineer.

7.3 The Installation Contractor shall then at his own, or his insurer's cost, be responsible for all such damages, except for damages so listed previously.

E232 TRIPPING AND EMERGENCY LIGHTING BATTERIES AND TRICKLE CHARGERS

1. General

1.1 The trickle chargers and battery cabinets shall be provided as specified*** and as indicated on the drawings.

1.2 Each set of batteries shall be provided with a separate battery charger.

1.3 The battery bank and charging equipment shall be housed in a floor-standing metal-clad cabinet as one unit if nickel cadmium batteries are used. Lead acid batteries shall, however, be housed in separate free-standing treated hardwood racks.

1.4 The battery charger shall be connected to a terminal block at the back of the switchgear panel by means of PVC cable and shall be supplied from the voltage transformers where no external supply is available.

1.5 No fuses shall be installed in the trip circuits from the batteries to the switchgear panels.

2. Batteries

2.1 Where spring charging motor and solenoid mechanisms are used, 110V battery sets shall be provided for the supply of the mechanisms, as well as for tripping and closing coils. 110V Battery sets shall also be provided for 33kV and higher voltage substations. In all other cases, 32V battery sets shall be provided unless otherwise specified***.

2.2 The battery sets shall be capable of providing the full standing load of all associated equipment during complete failures of the AC supply, for a minimum period of 6 hours, after which period it shall be possible to open and close all circuit breakers once in rapid succession. The battery sets offered shall be fully capable of providing the load requirements of all motors, lamps, relays, coils, etc.

2.3 Lead acid battery sets shall be housed in a hard-wood cabinet, finished in alkaline or acid resistant paint, whichever is applicable. The cells shall be so arranged that the electrolyte is clearly visible and to allow for easy maintenance of the batteries.

2.4 All batteries shall be of the Ni-cad type unless otherwise specified.

2.5 Lead-acid type batteries shall be used for large substations which will be specified in the project specifications*** if required.

2.6 The batteries are to be contained in non-corrodible transparent cases to enable electrolyte levels to be easily checked, with high and low level marks clearly visible.

3. Charging Equipment

3.1 Rectifier

1) The unit shall comprise a double wound transformer with solid state type rectifier.

2) The output voltage variation shall be not more than ±1% for variations of ±10% of the input voltage at the temperature ranges specified for the site.

3) The charger shall be of the constant voltage control type with a higher (booster) and lower (trickle) rate of charge. The higher rate of charge shall be such as to completely charge a fully discharged battery in a period of 15 hours.

4) The capacity of the charger shall be rated to provide the full standing load plus battery charging current, for the specified ultimate loads.

3.2 Instruments

The following minimum instruments are required:-

1) DC ammeter - charging current
2) DC voltmeter

3.3 Indication Lights

An indication light is required to indicate that the AC supply is switched on.

3.4 Switches and Fuses

The following switches are required:-

1) A main switch to isolate the AC input.
2) Fuses on the DC and AC sides except in the trip circuit.

3.5 Control of the Charge Rate

The following are required to control the rate of charge:-

1) A push button or switch to select the higher rate of charge.

2) A timer to switch over automatically from the higher rate to the lower rate of charge after a period adjustable from 1 to 10 hours.

3.6 Protection and Alarms

1) If a standing load is to be supplied to switchgear and control panels then the following protection systems with alarms shall be provided to trip the standing load supplies:-

   (a) AC supply fail relay with time delay
   (b) DC under-voltage relay with 90% setting

   (c) Tripping indication for the above conditions

2) If supervisory indication is specified for the system then a charger failure

alarm relay shall be provided and the auxiliary switches of all the relays including the above-mentioned, shall be wired to an easily accessible terminal block in the charger cabinet.

3) Where a standing load is to be supplied from the battery unit, the standing load supply shall be separated from the tripping and control supply. The standing load supply only shall be automatically disconnected in case of:-

a) Failure of the AC supply

b) The battery voltage falling below 90% of the nominal voltage.

4. Installation

4.1 The units shall be properly bolted on floors where possible.

4.2 The charger shall be connected to the AC supplies.

4.3 The batteries shall be connected to the switchgear or light fittings (stand-by lights) where applicable, by means of suitable PVC cable.

4.4 All battery electrolyte levels shall be checked and corrected if necessary.

4.5 The battery sets shall be fully charged.

4.6 The metal work of all units shall be correctly earthed to the substation earth bar by means of 70 mm² stranded copper conductor or 30 mm x 3 mm copper bar.

E234 VARIABLE SPEED DRIVES (VSDs)

1. General

1.1 The VSD shall comply with Part 4A and Part 4B where applicable with special reference to cubicle construction, wiring of cubicles and accessories.

1.2 The supplier of the VSD shall be responsible to ensure that the variable speed drive system, the motor and feeder transformer are fully compatible as a system. If the motor is supplied under a separate contract it shall be the responsibility of the supplier of the VSD to obtain all the relevant information from the motor Contractor.

1.3 Unless otherwise specified the VSDs shall be suitable for centrifugal pumps with a squared torque characteristic***.

1.4 Where VSDs are offered which operate at other voltages, than the motor or the system, step down or step up transformers shall form part of the offer. The ratings of the transformer shall be compatible with the drive requirements taking harmonics into account.

1.5 Only very high reliability and availability of equipment shall be acceptable. This shall be achieved by state of the art designs, high quality control standards, first class workmanship, best available materials and components, sufficient redundancy and adequate derating factors. Materials shall be capable of withstanding the variations in temperature arising under working conditions without distortion or deterioration.

1.6 Components which are standard for number of product ranges of the manufacturer shall be used.

1.7 The colour of the VSD shall be specified in the project specification***.

1.8 The availability of spares shall be guaranteed for 10 years after the contract is accepted.

2. Pulse Width Modulated Drives (PWM Drives) for Induction Motors

2.1 This specification covers VSDs incorporating a method where a variable frequency and variable voltage shall be applied to a standard squirrel cage induction motor in order to vary the speed of the motor.

2.2 The method of operation shall be as follows : A 380 to 1000V AC/50 Hz supply shall be converted into dc via a transistor controlled converter and a dc capacitor after which the dc current shall be inverted to VAC by means of a thyristor and diode controlled inverter. This ac current shall then be fed the induction motor.

2.3 The rectifier and converter shall be 6 or 12 pulse as specified.***

3. Power Supply Details

The VSD shall be suitable for continuous operation when fed via a step down transformer if specified in the project specification*** from a 3-phase power supply having the following characteristics :

- System voltage : Specified in the project specification***.
- Motor voltage : Specified in the project specification***.
- Voltage fluctuations : +10% to 15%
- Nominal frequency : 50 Hz, ±2½%
- Phase rotation : R-Y-B-R anti clockwise
- System fault level : Specified in the project specification***.

4. Supply Interruptions and Distortions

4.1 The VSD shall be capable of operation without damage and without interruption under the following power supply distortions and interruptions.

- Total interruptions and restoration after 300 milliseconds.
- Loss of one phase and restoration after 300 milliseconds.
- Reduced phase voltage of one or more phases by up to 30 (thirty) per cent below nominal for up to 3 seconds.
- Negative phase sequence voltage of 2½ per cent (continuous).
- Supply voltage total harmonic distortion of 3 (three) per cent with individual voltage harmonic distortion of one per cent.

5. Harmonics

The harmonics generated by the VSD shall be compensated if necessary not to exceed the following levels:

- Any individual harmonic voltage may not exceed 1%.
- The total harmonic voltage may not exceed 3%.
- The current harmonics may not exceed 5% of the current rating of the equipment.

The Contractor shall also carry out a system study to determine filter requirements so as to limit the distortion to the 11 kV system, as measured at the 11 kV system, to the specified levels.

Any equipment which is sensitive to harmonics shall be designed to function under voltage conditions which may have up to 5% total harmonic voltage distortion and up to 2% individual harmonic voltage content.

6. Ratings

6.1 The electronic devices of the variable speed drive shall be continuously rated for a motor shaft output of 15% in excess of the power required by the pump at any speed over the whole speed range. The details of the motor are specified*** in the project specification if not forming part of the contract.

6.2 Each VSD shall be capable of continuous duty at full rating (24 hrs/day, 365 days/annually) under the specified power supply conditions.

7. Speed Range Requirements

The speed of the variable drive shall be continuously variable between the lower and upper speed limits. The lower speed limit of the VSD shall be at least 10 per cent below the minimum and 10 percent above the maximum speed required for the driven pump. The speed range of the VSD are specified*** in the project specification.

The drive system shall also have the facility to inhibit operation at pre-determined speeds to prevent system resonance.

The speed control stability tolerance shall be better than 1,0 per cent of the set point.

8. VSD Electronic Equipment and Components

8.1 The control circuitry shall consist of independent electronic control and protective circuits arranged on separate PCB's. This circuitry shall be isolated from the mains supply by means of isolating constant voltage transformers (CVT's) in order to limit malfunctions due to transients and voltage dips on the system.

8.2 The electronic equipment shall be of modular construction mounted on plug-in boards. Modules shall be easily removable to ensure rapid rectification of faults by module replacement. Such modules shall be suitably coded so as to prevent insertion into wrong sockets.

8.3 The material used for the printed circuit boards shall be of the best quality.

8.4 The connections to the printed circuit boards shall, wherever possible, be made by means of suitable connectors with gold-plated contacts that are designed to be soldered to the tracks of the printed circuit board.

8.5 The printed circuit board assembly shall be protected from deposits of dust and moisture by coating with suitable material (e.g. conformal coating material complying with BS 5917).

8.6 Means shall be provided for mounting the printed circuit board assembly inside the enclosure so as to facilitate easy insertion and withdrawal of the assembly. The assembly shall be mechanically secured so as to prevent vibration.

8.7 The printed circuit board assembly shall be designed with suitable means of self diagnostic indication of faults and indication of status for the purposes of setting up easy service and maintenance, or shall be provided with easily accessible test points to facilitate diagnostic tests for faults. Suitable test equipment shall form part of the contract.

8.8 The power supply to electronic control equipment shall be provided with an electrostatic screen between the primary and secondary windings. The screen shall be connected directly to earth.

8.9 Electrolytic capacitors used in the dc application of electronic equipment (e.g. filter circuits) shall be of the long-life grade complying with IEC Publication 384-4.

8.10 All semiconductor devices, power transformers, chokes and other components forming necessary parts of the drive equipment shall be suitable for the particular application with respect to their rated voltages, rated currents, temperature rise and service life.

8.11 Solid state electronic components shall be used.

9. Digital Technology

Digital control based on the latest microprocessor technology shall be used. However, standard products and components shall be used and purpose made systems shall not be acceptable.

10. Modbus RTU Interface Protocol

When specified*** in the project specification the VSD shall be equipped with MODBUS RTU interface protocol with facilities to report all fault conditions on a first in first out basis as well as control functions and the parameters during normal running condition. A suitable data storage buffer shall be provided of sufficient capacity to ensure a real time record of the above information and of any other variables the Contractor consider necessary for fault diagnostics.

11. Control Card Monitoring

All control cards shall be provided with suitable monitoring, either by means of on-board identification, or if specified*** via the modbus interface to permit identification of and replacement of faulty control card with a minimum of drive downtime.

12. Hardwire Trip Interlocks

12.1 Protection devices in the VSD shall be hardwired to ensure that an electrical fault within the controller trip the transformer feeder circuit breaker.

12.2 Electrical interlocks shall be provided to trip the VSD in the event the access doors to the power section and the DC sections of the drive being opened.

13. Main Power Equipment

The main power equipment unit shall comprise the following:

13.1 AC power supply incorporating a fused isolating switch. It shall be possible to visually observe the isolator contacts in the open position from the front of the panel.

13.2 The contactor unit.

13.3 Rectifying transistors and inverting thyristors.

13.4 A choke in series with the rectifying transistors (input) shall installed to limit the inrush current.

13.5 By-pass switch if specified*** in the project specification.

13.6 Auxiliary power supply equipment.
13.7 Step down transformers if required.

14. Cubicle Arrangement

14.1 Smaller VSD's shall be mounted into a free-standing MCC panel suitable for floor fixing.

14.2 The Contractor shall confirm within two weeks after appointment that the cubicle as offered by the Contractor can be installed in the MCC room by studying the appropriate construction drawings.

14.3 The VSD equipment e.g. fused isolator, contactor, thyristor stock, control circuitry, etc., shall be housed in separate compartments or cubicles.

14.4 When more than one cubicle/panel is provided, the cubicles shall form a straight line and be of the same height. All cubicles shall be braced and of modular bolted construction to form a rigid assembly. They shall be provided with a substantial channel iron base which shall prevent distortion transportation and installation.

14.5 The equipment shall be arranged so that the various parts of the drive are easily accessible.

14.6 The instrument and control panel shall be flush mounted on the front of the cubicle at a comfortable height from the ground.

14.7 The main isolator handle shall be mounted on the front of the cubicle and shall be door inter-locked.

14.8 IP54 enclosure protection shall be provided unless otherwise specified*** in the project specification.

14.9 The VSD unit shall conform with the rest of the MCC panel e.g. colour shall be matched, labels shall be matched, etc.

14.10 The cable entry shall be below unless otherwise specified***.

15. Ventilation

The temperature in the MCC room may rise to 45°C unless otherwise specified*** and the equipment shall be rated to operate at this temperature.

15.1 The transistors/thyristors shall be forced air cooled by means of fans.

15.2 The fans shall be mounted directly above the transistor/thyristor stacks on top of the cubicle. The fans shall be suitably electrically protected with miniature circuit breakers. Fans shall have an associated air differential pressure gauge to ensure that the drive shall be tripped on cooling system failure. A standby fan shall be provided, operating automatically on failure of the duty fan.

15.3 Replaceable air filters shall be provided at the air-intake of the cubicle.

15.4 The hot air shall be exhausted into the room.

16. Protection

Variable speed A.C. drives shall be provided with the following integral protection features. <u>A separate motor protection relay shall be provided if these features are not part of the VSD protection features</u>. The Contractor shall explain how each requirement is met in his drive and shall supply detailed supporting literature for each item.

16.1 Thermal Overload

The relay shall have current time characteristics matched to the thermal damage curve of the drive motor.

16.2 VSD and Motor Short Circuits and Earth Faults

The drive and the motor shall be fully protected against internal and external short circuits and earth faults on the supply connections, transformers, the DC link, or on the motor. This protection shall preferably be instantaneous in operation and arranged to trip the supply. It shall not operate incorrectly if the drive is able to feed current to a supply side fault unless the condition is sustained for long enough to damage the drive components.

16.3 Negative Sequence Voltages

The motor shall be protected against negative sequence currents resulting from the presence of negative sequence voltages on the supply lines, or produced by unbalanced operation of inverters, etc., protection shall be provided which detects the condition and stops the drive before it or the motor can be damaged. The drive shall be able to operate continuously at the rated output if the negative sequence voltage on the supply does not exceed 2,5%.

16.4 Loss of Supply Voltage

If the positive sequence voltage to the drive should fall below 85% for longer than 1 second, the drive shall be disconnected without any damage to the rectifiers, thyristors, or any other components in the drive liable to adversely affected by a low supply voltage condition.

An under voltage trip which is pre-settable to a minimum of 15% voltage drop shall be provided.

If the voltage drops more than the pre-set voltage above the drive shall trip automatically. In the event of the supply voltage returning to a value which is greater than the pre-set voltage in less than 2 seconds, which is also pre-settable, the drive shall automatically start up. A facility to enable the flying start, shall be provided on the drive.

The variable speed drive system shall be able to tolerate a sudden total loss of power without any damage to the drive. See 4.1

16.5 Overtemperature inside Cubicle

In the case of drives above 100 kW, RTD temperature protection with alarm and trip set points shall be provided in the cubicle and be arranged to stop the drive for high cooling air temperatures. Indication of overtemperature shall be provided on the front of the panel and one spare set of potential free contacts shall be provided for alarm purposes.

16.6 High Supply Voltage

If the supply voltage should rise above 110% for more than the safe withstand time for all components in the drive, it shall be disconnected automatically.

16.7 Electronic Equipment

This shall be provided with all protection equipment necessary to ensure that diode overvoltages, overcurrents, or other transient conditions will not result in component failure. Such protection shall be arranged to disconnect the drive, where necessary for its safety.

16.8 Loss of Phase

Loss of a supply phase shall cause the drive to be disconnected sufficient rapidly to prevent damage.

16.9 Incorrect Phase Rotation

The drive controls shall be capable of detecting this condition and preventing start-up.

16.10 The drive shall also be protected against the following faults:

FAULT

Over voltage in the dc link
Under voltage in the dc link
Overcurrent in the inverter
Motor stalling
Transient surges
dv/dt and di/dt
Overspeed
Open motor circuit
Transistor overcurrents by means of HRC fuses

16.11 Audible and visible indication shall be provided for all trip and alarm functions.

16.12 Indications and Transducers
All protection functions shall be complete with the necessary current and voltage transducers and the condition that originated any drive shutdown shall be indicated clearly on approved operation indicators.

The following are examples of indications to be displayed on the panel door. Contractors shall provide information of fault indications offered applicable to the equipment.

1. Overspeed trip.
2. Instantaneous overcurrent trip.
3. Inverse time overcurrent trip.
4. Converter over temperature trip.
5. Earth fault trip.
6. Converter ventilation fan failure trip.
7. Cooling fan failure.
8. Power supply low voltage trip.
9. Back-up electronic trip.
10. Supply phase-loss and incorrect phase rotation protection trip.
11. Stator winding over temperature alarm/trip.
12. Bearing over temperature alarm/trip.
13. Earth alarm/trip.
14. External fault.
15. Long starting time.
16. Over temperature (Transformer).
17. Surge arrestor (Converter).
18. Surge arrestor (Motor).
19. Underspeed trip.
20. DC current monitor.

16.13 Remote Indication

A potential free contact wired to terminals at the back of the panel shall be provided to indicate a system fault for remote indication.

17. Control Indication and Instrumentation

The following minimum controls and instrumentation shall be provided on the front panel of the electronic compartment:

17.1 Controls

a) Start/Stop push buttons for local operations.

b) Emergency stop push button:

The push button for the emergency stop shall be red, only manually resettable and will prevent the motor from starting from the local or any remote position. (Parallel circuitry to a terminal block to be provided for a similar switch at the motor).

c) Local/Remote switch shall be provided.

d) Test/Off/Normal : This switch shall operate with a key removable only in the normal position. In the test position the complete starting and tripping sequence shall be operational for testing without applying power to the motor.

e) Protection trip reset push buttons.

f) Indication test push button to test lamps.

g) Speed control.

17.2 Signal Lamps and Push Buttons

The following main colour-codes shall be used for signal lamps and push buttons.

a) Signal Lamps

Trip	:	Red
Run, Ready	:	Green
Speed Control Healthy	:	White

b) Push Buttons

Stop Emergency	:	Red
Run	:	Green
Trip Reset	:	Blue
Lamp Test	:	White
Siren Mute	:	Yellow

17.3 Instrumentation

a) LCD Display.

b) Ammeter on all the phases with instantaneous reading and overscale facility.

c) Speed meter.

d) Voltmeter with selector switch for phase to phase and phase to neutral readings.

e) Ammeters for the heater circuits.

f) Non-resettable running hour meter.

*17.4 Remote Control and Indications (When specified*** in project specification)*

The variable speed drives shall be suitable for future remote control operation and monitoring. All the required functions and signals shall be wired to terminal blocks which are easily accessible. The following functions control signals are considered as a minimum. The design will however be finalised with the successful Contractor:

a) Control functions:

- ON/OFF
- Start to minimum speed
- Speed control (4 - 20 mA signal)
- Stop

b) Indications:

- Machine ready
- Speed indication (4-20 mA)
- Temperature trip
- Common protection trip
- External trip
- Local control
- Cubicle overtemperature
- By-pass closed (if applicable)
- Emergency stop

- Amps (load current)
- Volts

18. Training

The Contractor shall allow for two on site training sessions. The sessions shall last at least one full day and include programming and setting up procedures of the VSDs.

E237 STREET- AND SECURITY LIGHTING

1. General

Street and security lighting shall in general conform to SABS 098, unless otherwise specified.

2. Steel Poles for Streetlighting

2.1 General

All steel streetlighting poles shall be properly treated against corrosion. Painting and/or galvanising shall be carried out in accordance with Specification E202.

2.2 Design

1) All steel poles shall be designed to withstand all static and dynamic loads on the pole, fittings and street lighting brackets with a minimum factor of safety of 2,5 in compliance with the Occupational Health and Safety Act (85/1993).

2) The pole shall be designed to withstand a wind speed of 120km/h (unless otherwise specified in the project specification) at a height of 10m above ground level and exerted on the projected area of the pole, fittings and street lighting brackets.

2.3 Base Plate

1) Each steel pole shall be equipped with a suitable base plate, at least 350mm in diameter or square plates with an equal or larger surface area.

2) The base plates shall be held in position by means of steel hook bolts to be hooked into the steel pole. The plates are not to be welded to the steel pole. The base plate shall have the same finish as the pole.

2.4 Steel Sleeve

1) All steel streetlighting poles shall be provided with a 6 mm thick and 1,0m long steel sheath, if specified*** in the Project Specification.

2) The sleeve shall extend 500mm above and 500mm below ground level after installation.

3) The steel sleeves are to be welded or shrunk onto the poles.

2.5 Protection of Poles against Corrosion

1) Poles shall be completely galvanised and/or painted as specified*** in the Project Specification. Galvanising and painting shall be done in accordance with the Standard Specification E202. The interior of poles to be used at

coastal areas, or if specified*** in the Project Specification shall in addition be coated with at least one coat of suitable bituminous paint.

2) The lower 2,0m of the pole including the base plate, shall be painted on the outside with two coats of suitable bituminous paint.

3) After erection on site a final coat of paint shall be applied to the pole if specified*** in the project specification.

2.6 Size of Spigots

Contractors shall ensure that the diameters and lengths of the pole spigots shall suit the types of luminaires offered.

2.7 Cable Entries

1) Each steel pole shall be provided with a suitable cable entry hole. The hole shall be so located that after erection the entry hole shall be approximately 700mm below ground level.

2) The edges of the cable entry hole shall be smooth to prevent damage to cables.

3) The dimensions of the entry hole shall be such that two 25mm², 4-core PVC insulated steel wire armoured cables can be easily installed. The project specification*** will state whether ECC cables shall be used.

2.8 Cable Termination Compartment

1) Each pole shall be provided with a suitable cable termination compartment with a bracket complete with a 5A, 5kA miniature circuit breaker mounted on the bracket. Each luminaire shall be protected by a circuit breaker on double outreach installations.

2) An earthing stud welded to the inside of the pole shall also be provided inside the compartment. The earth conductors of the incoming cable and the earth conductor from the luminaire shall be terminated on the same earthing stud.

3) The cover of the compartment shall be watertight and sealed with a gasket. It shall be retained by a lug and secured by a bolt with a seven sided shrouded head.

4) The compartment shall incorporate a suitable gland plate for the termination of the incoming cables.

2.9 Pole Mounted Protection Boxes

Where steel streetlighting poles are to be used in an overhead reticulation system, the pole shall be provided complete with a pole mounted weatherproof PVC circuit breaker box with tripping lever fitted with a 5A, 5 kA single phase miniature circuit breaker.

3. Wooden Poles for Streetlighting

3.1 Wooden poles shall be suitably treated and shall comply with SABS 753 or 754.

3.2 The dimensions and classes of wooden poles required shall be as specified*** in the Project Specification.

3.3 Wooden poles shall be equipped with either "Pratley" type underground cable T-off boxes or galvanised junction boxes to be mounted above ground level as specified*** in the Project Specification.

3.4 Where underground "Pratley" type boxes are specified*** for use or where poles are to be used in an overhead distribution system, the wooden poles shall be provided with a pole mounted weather-proof circuit breaker box with tripping lever fitted with a 5A, 5kA single phase miniature circuit breaker.

3.5 Where an above ground termination box is specified, Contractors shall allow for the provision of this box in their tender prices. The box shall be galvanised and fitted to the pole with galvanised clamps. The box shall be equipped with a 5A, 5kA miniature-circuit breaker. The lid of the box shall be fixed with countersunk bolts. The box shall be watertight and shall be mounted approximately 500 mm above ground level.

3.6 In the case of 3.4 above galvanised steel pipe shall be provided against the pole to serve as a cable protection sleeve. The diameter of the pipe shall be suitable to allow easy installation of a $25mm^2$, 3-core steel wire armoured PVC insulated cable. The pipe shall be fixed to the pole with suitable clamps at intervals of not more than 500mm. The pipe shall extend 2,0 meter above ground level and 500mm below ground level.

3.7 In the case of 3.5 above where an above ground termination box is called for, a cable sleeve as specified above shall be provided above the box. Two similar galvanised pipes, each suitable for a $25mm^2$, 4-core cable shall be provided below the box. The pipes shall fit over the cable glands complete with neoprene covers suitable for the cable sizes. The pipes shall extend 500mm below ground level.

4. Midhinge Type Masts

4.1 General

1) The masts shall be similar or equal to the scissor type as manufactured by Sectional Poles Africa.

   The Engineer shall decide whether any mast offered complies with this requirement.

2) The masts shall comply with the relevant clauses as specified for steel poles, above.

4.2 Construction

1) The lower half of the masts shall be divided into two fully enclosed half sections, which shall form an octagonal section in the operating position with no unsightly steps or protrusions.

2) The pivot shall be located approximately at the mid-point of the mast and shall consist of two full length stainless steel sleeves and not a shaft and hinge plates.

3) The pivoting half of the mast base section shall be securely bolted to the base plate by means of an adequately designed vandal proof securing system. A special socket type spanner shall be provided for this securing

system.

4) Street light brackets for mounting of luminaires, shall be provided as specified in the relevant clauses for street poles as specified above.

5) The pivoting half of the base section shall be balanced in such a manner that lowering can easily be done by one person using a nylon or stainless steel rope without additional equipment being required. The lowering of the pivoting section of the masts shall not be by a winch, power tool or bolt type lowering mechanism.

6) A safety chain shall connect the pivoting half with the fixed half to prevent accidental lowering or damage to the trailing cable.

7) A galvanised or stainless steel wire rope shall be affixed to the top and bottom of the masts on the inside to allow the electrical cable to be strapped to it.

8) The fixed part of the mast shall be provided with a cable termination compartment as specified in the relevant clauses for steel poles as specified above.

4.3 Foundation

1) A concrete foundation shall be provided for each mast unless otherwise specified.

2) The foundation designs shall be submitted with the tender/quotation and the successful Contractor shall provide foundation drawings.

3) Adequately designed foundation bolts, made from mild steel, shall be provided with each mast together with templates.

4.4 Corrosion Protection

1) The mast shall be corrosion protected to comply where applicable.

2) All materials used in the pivot construction shall be of AISI grade 316ℓ stainless steel.

3) Steel used for the construction of the masts shall be SAE 950X grade B and shall be a high tensile low carbon type or equivalent.

4.5 Design

1) The design of the mast shall comply with the relevant clauses or specification for steel poles, above.

2) The mast shall be capable of withstanding the loads impacted on it when being lowered.

3) The following design calculations shall be submitted:

   a) The mast in wind conditions;
   b) The mast during lowering.

5. High Masts

5.1 High masts shall be provided in the positions as indicated on the drawings.

The positions indicated on the drawings are only approximate positions: the Contractor shall ascertain from the Engineer what the final positions are on site and shall peg the positions prior to commencing excavation work for the bases.

5.2 Construction

1) The masts shall be manufactured from mild steel in accordance with SABS 1431, which shall be of a grade suitable for the working loads.

2) A base plate of suitable thickness shall be welded to the bottom end of the mast and shall be suitably pre-drilled for the foundations bolts. Gussets shall be provided between the bolt holes for increased structural strength.

3) All welding shall be subject to SABS inspection and acceptance certificates shall be provided to the Engineer.

4) The selected cross-section and wall thickness of the masts shall be based on working load calculations.

The design shall be approved by a Professional Structural Engineer appointed by the Contractor for this purpose.

5) The masts shall give an overall floodlight mounting height as specified*** in the project specification.

5.3 Working Loads

1) The design of the masts shall comply with the relevant clauses as specified for steel poles, above.

The design shall take into consideration the increase in wind speed with height and a design based on a constant wind loading over the entire length will not be accepted.

2) The Contractor shall ensure that the design is carried out in accordance with:

SABS 0160 - 1980 :	Code of Practice for the General Procedure and Loading to be adopted for the Design of Buildings.
SABS 0162 - 1989 :	Code of Practice for Structural Steelwork.

3) The Contractor shall, prior to commencing with the construction of the masts, submit to the Engineer his approved design drawings, detailed design calculations and any other substantiating data to prove that the requirements of the specification have been met.

4) In addition to the above, information relating to the following shall be submitted with tenders:

a) Dynamic behaviour of the masts with respect to wind-induced oscillations and resonance.

b) Deflection of masts and resultant stresses and bending moments over the entire length of the structure at maximum wind loading.

5.4 Luminaire Carriage and Raising and Lowering Mechanism

1) The masts shall be fitted with a luminaire carriage suitable for carrying the specified luminaires and which, when raised to the operating position, shall always be correctly aligned. Indication shall be provided to show when the carriage is in its fully raised position.

2) An electrically operated raising and lowering mechanism shall be provided for the luminaire carriage.
Where a separate unit has to be used for the raising and lowering operation, only one unit shall be provided for all the masts.

5.5 Access Opening

An access opening suitably designed to maintain the mast strength shall be provided 600 mm above the base plate and shall be fitted with a hinged weatherproof door. The door shall be fitted with a lock suitable for preventing vandals from gaining access to the electrical equipment housed in the mast.

The electrical equipment for controlling the luminaire shall be readily accessible for operating and maintenance through the access opening.

5.6 Corrosion Protection

1) The mast shall be corrosion protected to comply where applicable with the relevant clauses as specified for steel poles, above.

2) All parts of the mast and the luminaire carriage which are not manufactured from stainless steel shall be hot-dip galvanised to SABS 763-1977 and inspection certificates shall be provided.

5.7 Electrical Control Equipment

1) Each mast shall contain a glass fibre distribution board (DB) mounted inside the mast shaft opposite the access door.

2) Each phase of a multiple phase connection shall be protected by a single phase 5 kA miniature circuit breaker and a lightning arrester. The DB shall further contain the electrical control equipment as shown on the drawings or specified*** in the project specification. A suitable supply connection for the hoist unit shall also be provided.

5.8 Lightning Protection and Earthing

1) Each mast shall be fitted with a lightning spike projecting above the head assembly to protect the luminaires.

2) An earth stud shall be provided near the base and connected to an earth rod and the distribution board earth bar.

5.9 Mast Foundations

1) A reinforced concrete base shall be provided for each mast as generally shown on the drawings.

2) The base shall be designed by a Professional Structural Engineer appointed by the Contractor. The Contractor shall measure the soil bearing pressure at each location prior to the bases being designed.

3) When the bases are cast, test cubes shall be taken and submitted to an approved test laboratory. The results shall be submitted to the Structural Engineer for his approval.

4) After the masts have been installed on their bases a final inspection shall be carried out by a Structural Engineer and the installation shall be approved in writing.

5) After casting of the foundation base, the slab shall be covered with earth which shall be properly compacted. The area around the base shall be brought to the original level and shall be left neat and tidy with no excess soil.

6. Luminaires

6.1 High masts and poles shall be fitted with luminaires as specified*** further herein and in the Project Specification.

6.2 The final adjustment of the luminaires shall be done on site to provide area lighting to the Engineer's satisfaction.

6.3 Luminaires shall consist of a cast aluminium or aluminium alloy or fibreglass reinforced polyester housing, high quality non-deteriorating reflectors and an acrylic lens. The lens material shall not discolour or lose its translucence with time. Polycarbonate is not acceptable. The complete fitting shall be corrosion resistant.

6.4 Where control gear is required for operation, the control gear housing shall form an integral part of the luminaire. Intertap chokes, to enable optimum operation from 200V to 250V, shall be provided if specified*** in the Project Specification.

6.5 The luminaires shall be fully gasketed to eliminate the ingress of dirt and moisture.

6.6 All luminaires offered shall be of high quality and of a type approved by the Engineer.

6.7 Unless otherwise specified the types of luminaires offered shall be in accordance with the types recommended in SABS Code of Practice 098, 1277 and 1279 for the various types of roads and classes of installations.

6.8 The type of lamps is specified*** in the Project Specification and Contractors may offer alternative wattage lamps that will provide the specified lighting levels.

7. Photo-Electric Cells for Streetlights and High Masts (Refer to Clause E205)

Where photo-cells are called for in the Project Specification*** for the control of streetlighting, the photocells shall comply with the following requirements:

7.1 The photocell shall be mounted on the pole nearest to the minisub, substation or low voltage distribution cubicle.

7.2 All photo-electric cells shall be provided with suitable mounting brackets to mount these on the streetlight pole.

7.3 The photo-electric cells shall be so mounted that light of the streetlight fitting shall not interfere with the proper functioning of the photo-cell.

8. Streetlighting Arms

8.1 Streetlight brackets shall be used for the mounting of luminaires on wooden poles and steel poles where the arms do not form an integral part of the pole.

8.2 The brackets shall be galvanised and, if called for, painted as specified in the Standard Specification E202.

8.3 The brackets shall consist of a tubular section with suitable struts and braces to ensure sufficient mechanical strength and rigidity as shown on the drawings.

8.4 The dimensions of the spigot shall be suitable for the type of luminaires offered.

8.5 The bracket shall be fixed to the pole by means of at least two clamps with bolts, nuts and washers. All parts shall be galvanised.

8.6 The tubular section shall be such that the cable entry opening faces downwards to prevent the entry of water into the arm and luminaire.

9. Installation of Streetlighting

9.1 Contractors shall allow in their tender prices for the following:

1) Pole hole and/or foundation excavations.

2) Concrete foundations for midhinge and high masts.

3) Erecting, backfilling and consolidating. This includes the ensuring that poles are plumbed and aligned.

4) Terminating of the underground streetlighting cables where applicable.

5) Connection of the cable earthing conductors to the earthing studs by means of bare copper earth wires and crimped ferrule connections.

6) Mounting of luminaires, brackets, miniature circuit breakers, connection boxes, cable protection sleeves, etc.

7) Supply and installation of internal 3 x 4mm² PVC insulated copper conductors from the connection box to the luminaires on steel poles. On double outreach standards, each luminaire shall be separately wired to its miniature circuit breaker.

8) Supply, installation and termination of 4mm², 3-core PVC insulated cable on wooden poles.

9) Supply, installation and termination of three 4mm² PVC insulated copper conductors from overhead lines to pole mounted miniature circuit breakers and to luminaires.

10) Supply, installation and termination of cable internally installed in high masts.

11) Balancing the load evenly over all three phases.

12) Testing and commissioning of the complete assembly.

9.2 All luminaires shall be installed complete with the types of lamps specified.

9.3 All luminaires, steel brackets and poles shall be properly earthed.

9.4 Where painting of streetlighting poles are called for, a final coat shall be applied after erection.

E241 LOW VOLTAGE ELECTRIC MOTORS

1. GENERAL

1.1 This specification covers low voltage (below 1000 V), 3 phase a.c. squirrel cage induction motors.

1.2 The motors shall be designed, manufactured, tested, delivered, erected and commissioned in accordance with:

SANS 60034	:	Rotating Electrical Machines, Parts 1 to 18
SANS 60072	:	Dimensions and output series for rotating electrical machines.
SANS 1804	:	Induction Motors, Parts 1 to 4

Where reference is made to a code, specification or standard, the reference shall be taken to be the latest edition, including addenda, amendments and revisions thereto.

All deviations from these specifications shall be clearly pointed out at tender stage as deviations not indicated, will not be accepted.

1.3 Motors of the same manufacture shall be used throughout the Contract unless otherwise approved by the Engineer.

1.4 Motors shall be designed for fixed speed or variable speed operation as specified in the Project Specification ***.

2. QUALITY OF MATERIALS

2.1 All materials shall be new, of the best quality and of the class most suitable for the application. All parts shall be capable of withstanding variations of temperature arising under working conditions without distortion, deterioration or setting up of undue stress in any part.

2.2 Quality control shall be in accordance with ISO 9001.

2.3 Mild steel plate for fabricated parts shall be of weldable quality in accordance with SANS 1431. No welding, burning in, filling, plugging up or metal deposition to correct defects in any component will be permitted unless agreed to by the engineer in writing, following an inspection on the defect.

3. INTERCHANGEABILITY

3.1 Motors of the same rating shall be interchangeable without them having to be modified.

3.2 The corresponding parts of motors that are identical, for all practical purposes, shall be interchangeable without them having to be modified. The same requirement applies to spare parts.

4. DRAWINGS AND INFORMATION FOR APPROVAL

The following drawings and information shall be submitted for approval before manufacture commences:

4.1 Dimensioned outline and required foundation drawings of the motors. (Shaft diameter, shaft height and motor mass to be clearly shown).

4.2 Cross-sectional dimensioned drawings of the terminal boxes.

4.3 Detailed drawings of the motor base plate showing full constructional details with dimensions.

5. INSPECTION OF MANUFACTURED EQUIPMENT

5.1 The Engineer, or his appointed representative, reserves the right to inspect the motors or associated parts at any stage of manufacture.

5.2 The Contractor shall ascertain at what stages inspections will be carried out and shall give the Engineer not less than seven days notice of when the inspections may be undertaken.

6. GUARANTEE AND MAINTENANCE

6.1 All motors provided under the Contract shall be fully guaranteed for a period of twelve months from the date of handing over.

6.2 A full maintenance service shall be provided during this period. The Tenderer shall indicate with his tender what duties have been included and the time intervals between services. Should the Tenderer fail to provide this information, the Engineer will lay down the duties as well as time intervals with which the Contractor shall comply.

7. MOTOR RATINGS

7.1 Motors shall have continuous maximum ratings not less than the following :

- 50 kW or under: not less than 25% in excess of the maximum likely to be drawn by the pumps within the operating range.
- Over 50 kW and up to 100 kW: not less than 15% in excess of the maximum likely to be drawn by the pumps within the operating range.
- Over 100 kW: not less than 10% in excess than the maximum likely to be drawn by the pumps within the operating range unless otherwise specified***.
- Where operating at other than continuous running duty is required, (i.e. short time or intermittent periods, as for valve actuators, hoists, etc.), motors shall have appropriate ratings in respect of output, duty and starting class.

7.2 The motor shall develop adequate torque to accelerate the driven equipment to full speed, within an acceptable time, using the starting method specified in the Project Specification ***. For direct-on-line (DOL) starting the motor voltage shall be taken to be 85% of the rated voltage. For other starting methods the motor voltage shall be taken to be the output voltage of the reduced-voltage starter.

7.3 Motors shall be designed to allow 6 starts per hour, of which two shall be consecutive.

7.4 Rated voltage shall be 400 / 525 / 690 V as specified in the Project Specification ***.

7.5 Rated frequency shall be 50 Hz.

7.6 The motors shall be capable of operating with Zone A combined voltage and frequency variations as defined in SANS 60034-1.

7.7 Rated speed shall be nominal 1500 rpm unless otherwise specified in the Project Specification*** and the operating speed range shall be as required by the driven equipment.

7.8 Motors shall be rated for continuous running i.e. Duty S1 to SANS 60034-1 and shall have a service factor of 1.

8. MOUNTING

8.1 The motors shall be mounted to suit the driven equipment. The mounting arrangement shall be as stated in the Project Specification***.

8.2 Motors shall be mounted on common base-plates with the driven equipment. When uncoupled from the load, it shall be possible to lift the motor clear without withdrawing the rotor and with the minimum amount of dismantling. Baseplates shall be provided with the driven equipment unless otherwise stated in the Project Specification***.

8.3 Motor feet shall be fitted with Grade 316 stainless steel jacking screws for both horizontal and vertical adjustment.

8.4 Mounting bolts shall be included in the motor's price, unless otherwise stated in the Project Specification ***.

9. ENCLOSURES AND COOLING

9.1 Motors shall be totally enclosed with a protection rating of IP55 in accordance with SANS 60034-5, unless otherwise stated in the Project Specification***.

9.2 The cooling system shall be in accordance with SANS 60034-6 and the cooling method (IC Code) shall be as specified in the Project Specification ***.

9.3 Ambient and cooling temperatures shall be in accordance with SANS 60034-1, unless otherwise stated in the Project Specification***.

9.4 Noise levels shall not exceed the levels permitted in SANS 60034-9.

10. WINDINGS

10.1 Unless otherwise specified in the Project Specification ***, thermal class and temperature rise of the motor winding insulation system shall be in accordance with SANS 60034-1 (i.e. Class F insulation, but Class B temperature rise).

10.2 With self-ventilated cooling systems, allowance shall be made for the speed dependency of heat transfer.

10.3 Converter-fed motors (variable speed drives) shall be rated to allow for additional harmonic losses in accordance with SANS 60034-17.

10.4 For converter-fed motors (variable speed drives), the motor manufacturer shall check the voltage stress withstand capability of the motor against the converter supplier's specification. To ensure that no service lifetime reduction of the motor insulation occurs, the actual stress due to converter operation shall be lower than the repetitive voltage stress withstand capability of the motor winding insulation system.

10.5 Functional evaluation of the winding insulation systems shall be carried out in accordance with SANS 60034-18 - 31. In the case of converter-fed motors, special attention is required because of the additional stress factors produced, such as increased voltage stress and high frequency repetition rate, additional heating as a result of harmonic losses, and mechanical vibrations.

11. BEARINGS

11.1 Type

Bearings shall be of the rolling- or sliding-element type as appropriate. Vertical shafts shall have approved thrust and guide bearings. Grease-lubricated bearings shall be sealed or regreasable.

Rolling-element bearings shall be loaded conservatively, in order that the grease may be renewed at intervals of not less than 4000 hours and they shall be equipped with grease nipples.

Where bearings are oil-lubricated, they shall be provided with a readily accessible filler and clearly visible oil level indicator. For large motors, forced lubrication may be provided as an alternative and details of the system shall be submitted with the tender.

Sliding-element bearings shall be fitted where rolling-element bearings cannot be fitted because of high speed, torque and/or bearing loads. Motors having sliding-element bearings shall be designed to allow measurement of bearing wear with a minimum of dismantling being necessary.

Sliding-element bearings shall be of the plain journal type, and not of the segmental type, and they shall be automatically lubricated by at least two oil rings or a single disc integrally mounted on the shaft, running in an oil bath of adequate capacity. The oil bath shall be fitted with a drain plug and an external oil level indicating device which is readily accessible or visible.

For sliding-element bearing motors employing forced oil lubrication, full particulars of the proposed lubricating system shall be submitted.

Care shall be taken that bearings are properly sealed in order to prevent ingress of bearing lubricant into windings and cores. For purpose of maintenance, end-shield bearings are preferred. A minimum L10 bearing life of 40 000 hours is required. Unless otherwise approved in writing, motor bearings shall be designed to allow the motor to run indefinitely when uncoupled from the driven machine.

11.2 Insulation

To prevent damage by any shaft currents which may be produced (e.g. on converter-fed motors), the bearings and their lubricating and cooling systems, shall be insulated from the bed-plate or frame. Although both bearings shall be insulated, the drive-end bearing insulation shall be shorted out with a copper earth strap to prevent the build up of static electricity on the rotor.

11.3 Flow Indicator

A flow indicator and/or pressure switch shall be provided on forced-lubricating systems to indicate failure of the system. Adjustable alarm and cut-out contacts shall be provided.

12. TEMPERATURE DETECTORS

12.1 All motors 55 kW and larger but smaller than 150 kW shall be provided with two PTC thermistors per winding suitable for class B temperature rise protection i.e. with reference temperature of 140°C. The three thermistors shall be connected in series via terminal blocks in the terminal box. (1 per winding connected to terminal blocks shall be spare)

12.2 All motors of 150 kW and larger shall be provided with two platinum resistance detectors (RTD's) of type PT 100 ohm per winding and one per bearing. The bearing detectors shall touch the outer bearing race and shall be spring loaded and of the screw type with weatherproof die cast alloy heads. The RTD's shall be of the three wire type with a stainless steel sheath and mineral insulation. When specified in the Project Specification*** the bearing RTD's shall be provided with 2 wire transmitters with a 4 - 20 mA output terminated in a die-cast cap.

12.3 The wires of all detectors must be wired to a terminal strip in a suitable terminal box on the motor.

12.4 When specified in the project specification*** the motor manufacturer shall provide a 1 inch BSP threaded hole in the motor casing to enable the installation of a bearing temperature probe by others.

13. ANTI-CONDENSATION HEATERS IN MOTORS

13.1 Anti-condensation heaters shall be built into the stators of motors and rated for a single-phase power supply of 230 V AC 50 Hz.

13.2 The terminals of the heaters shall be wired to a heater terminal box.

14. TERMINAL BOXES AND TERMINATIONS

14.1 The terminal box for the main supply cable(s) shall be adequately sized for the cables specified in the Project Specification***, and shall have a removable cover and gland plate. The degree of protection shall not be less than IP55.

14.2 Phase segregation shall be provided to prevent flashover, if the air and creepage distances between phases, and phases to earth are not adequate.

14.3 All terminals must be properly and permanently marked for easy identification.

14.4 Terminal boxes shall be on the left hand side if viewed from the drive end, unless other specified in the Project Specification***.

14.5 An explosion-relief diaphragm shall be provided to direct high pressure gases away from personnel who may be near the motor in the event of a terminal box fault.

14.6 Terminal boxes shall be fault-tested for both a through-fault and a short-circuit in the terminal box, based on the maximum fault level at the point of connection.

14.7 The terminal box shall be suitable for the cable termination method specified in the Project Specification***.

15. INFORMATION PLATES FOR MOTORS

15.1 In addition to the information required by SANS 60034-1, the following shall also be marked on the name plates:

15.1.1 Year of manufacture
15.1.2 The order number
15.1.3 Total mass of motor in kg
15.1.4 Diagram indicating the number, type and positions of heaters and temperature detectors if applicable.
15.1.5 Bearing types and sizes
15.1.6 Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

16. COUPLINGS AND DIRECTION OF ROTATION

16.1 Couplings between the motors and the driven equipment will be provided with the driven equipment unless otherwise stated in the Project Specification***.

16.2 The motor's direction of rotation shall be to suit the driven equipment, and the motor terminals shall be marked in accordance with SANS 60034-8.

17. BALANCE AND CRITICAL SPEED

Motors and couplings shall be accurately and efficiently balanced statically, and dynamically, so that there will be no unbalanced end-thrust, when either new or worn, and to eliminate noise and vibration when running.

Where end-thrust arises, adequate long-wearing thrust bearings shall be provided. Dynamic balancing shall be done by the removal of parent metal, in a manner which does not affect the structural strength of the rotating element.

The use of solder, or similar deposits for balancing, will not be accepted. The operating speed of rotating elements shall be below and as far removed as possible from the critical resonant speeds thereof.

The permitted levels of vibration generated within the motors shall not exceed the values given in SANS 60034-14.

Notwithstanding the acceptance of the vibration limits during the works test, the Engineer reserves the right to call for a vibration test on the installed equipment, if he considers it necessary and the Contractor shall be responsible for reducing the vibrations to within the specified limits.

The motors shall have a suitable margin of safety between critical speed and normal running speed. The first critical speed shall be not less than 120 percent of nominal speed.

18. TESTING

Motors shall be tested at the manufacturer's works, with the scope of the tests depending on whether the motors have been built to a new or proven design as set out below.

Four copies of all test certificates shall be submitted to the Engineer no later than when the motors are delivered.

18.1 New Designs (Type Tests)

Any single motor, or the first motor of any batch of identical motors, shall be subjected to the following tests:

(a) Resistance measurement (cold) of all windings and auxiliary devices
(b) Load test
(c) Temperature rise at full load and hot resistance of windings
(d) Speed / torque and speed / current curves
(e) Vibration and noise levels
(f) Verification of dielectric properties
(g) No load test
(h) Locked rotor test
(i) Measurement of starting, pull-up and breakdown torque
(j) Verification of degree of protection
(k) Overspeed test (if application can result in overspeed).

The remaining motors shall be tested as for motors built to a proven design.

18.2 Proven Designs (Routine Tests)

All motors that have been built to a proven design shall be subjected to the following tests:

(a) Resistance measurement (cold) of all windings and auxiliary devices
(b) No load test
(c) Verification of dielectric properties
(d) Insulation resistance test.

Type test certificates shall be provided for the motors that are only subjected to routine tests.

19. INSTALLATION

(a) The motors shall preferably be installed by the motor supplier, and shall be installed strictly in accordance with the supplier's installation instructions.

(b) To allow for interchangeability of motors, the motors shall be installed on 2mm thick corrosion-resistant shims to allow for shaft height variation.

(c) The motor frame shall be insulated from the baseplate if necessary to prevent circulating bearing currents with converter-fed motors. The coupling shall similarly be insulated if required.

(d) The motor shall be aligned to the driven equipment using laser aligning equipment or approved equivalent. Final alignment shall be done before commissioning may start, and shall be witnessed by the Engineer. Alignment shall be within the tolerances specified for the shaft coupling.

20. COMMISSIONING

Once the motor and driven equipment have been aligned successfully, the following minimum commissioning checks shall be carried out.

(a) Ensure that the switchgear controlling the motor, and any associated protection and metering circuits, have been checked fully. It is imperative to ensure that any trip and emergency shutdown circuits are working correctly before the circuits are energized.

(b) The motor windings shall be checked for dryness and also that the insulation resistance and polarization indexes have acceptable values, as recommended by the motor manufacturer.

(c) Check the earth connections to the motor frame and terminal box for tightness.

(d) Check all auxiliary services, such as oil and water for lubrication and cooling to ensure that there is adequate flow and that interlocks and protection circuits are operational.

(e) Check that all hazard warning signs, guards and covers are in position and securely fastened.

(f) Check separately-driven motor cooling fans for correct operation and rotation, and to ensure that interlocks and protection circuits are operational.

(g) Ensure that phase rotation of supply to motor has been checked. If there is any doubt and any risk of damage to the driven equipment, the coupling should be split and the motor run alone.

(h) Check that direction of rotation matches the marking on the motor to ensure correct functioning of shaft-mounted fan.

(i) Check shaft bearing and motor footing insulation if provided.

Should dampness in the windings be detected through the measurement of low insulation resistance (Item b above), then the motor shall be dried out and a withstand voltage test carried out at 80% of the test voltage recommended in SANS 60034-1 for factory testing (i.e. 80% of 2 V_R + 1 kV).

It is recommended that the test voltage for measuring insulation resistance be limited to 500 V dc, and the minimum acceptable insulation resistance shall be 1,5MΩ.

The method adopted for drying-out shall be by applying heat, preferably by circulating current through the windings or, alternatively, by means of space heaters located in and around the machine.

Insulation resistance measurements and temperature readings shall be taken regularly every half hour at the start of dry-out until the motor attains an even temperature and thereafter every hour. The characteristic dry-out curve of insulation resistance versus temperature shall be plotted and dry-out may be considered complete when the required polarization index is achieved.

All equipment and the personnel required for the drying out operation, shall be provided by the Contractor. The onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply. Any motor which fails as a result of being commissioned in a damp condition, shall be repaired free of charge by the Contractor.

PART D: ELECTRONIC AND TELEMETRY WORKS

PS4: Standard Electronic Specifications

CONTENT

STANDARD ELECTRONIC SPECIFICATION
F200 - PROGRAMMABLE LOGIC CONTROLLERS

1 SCOPE

This part of the standard specification gives detailed technical specifications which apply to PLC's (Programmable Logic Controllers).

2 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

IEC 61131 – Programmable Logic Controllers (All parts)

a) SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations

b)

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

SCADA – Supervisory Control and Data Acquisition

PLC – Programmable Logic Controller

CPU – Central Processing Unit

HMI – Human Machine Interface

I/O – Input/output

DCS – Distributed Control System

SCADA – Supervisory Control and Data Acquisition

3 GENERAL

A dedicated PLC shall be installed for each logical control area.

PLCs and their associated peripherals are generally intended to be used in an industrial environment and may be provided as open form or fitted within an enclosure. PLC's and associated peripherals which are intended for use in building automation systems, shall additionally comply with the specific requirements, standards and installation practices for building automation.

4 CLIMATIC CONDITIONS

The equipment shall be suitable for the operating temperature ranges given in Table 1 below.

	Type of Limit	Enclosed Equipment	Open Equipment
Temperature Range	Max	40^0C	55^0C
	Min	5^0C	5^0C

Table 1: Temperature Range

For non-ventilated equipment that is cooled by natural air convection, the equipment ambient air temperature is the temperature at a point not more than 50 mm away from the equipment, on a horizontal plane located at the vertical mid-point of the equipment.

For ventilated equipment, the equipment ambient temperature is the temperature of the incoming air, at a point not more than 50 mm from the plane of the equipment's air flow entry point.

No forced external cooling is assumed. Open peripherals, which are intended to be permanently installed as part of the PLC-system, shall meet the operating temperature range of the PLC.

The equipment shall be suitable for a relative humidity level from 10 % to 95 %, noncondensing.

Conformal coated printed circuit boards and components shall be supplied where the equipment is exposed to the following:

H_2S - Hydrogen sulfide
SO_2, SO_3 - Sulfur dioxide/trioxide
C_nH_n - Hydrocarbons
NO_x- Oxides of nitrogen
Cl_2 - Wet Chlorine/Dry Chlorine
NH_3 - Ammonia

The conformal coating shall comply with the ISA-S71.04 standard for Class G1, G2 and G3 environments.

5 EQUIPMENT

Hardware shall be field-proven under similar conditions and shall be protected against excessive temperature, electrical interference, input and output overvoltage or short-circuit.

The PLC 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. If a memory back-up battery is provided, a warning of "low battery voltage" shall be provided on the SCADA/HMI.
The CPU and I/O modules of the PLC shall be supplied with 20% excess application program memory and wired I/O capacity respectively for initial operation.

The PLC CPU model installed 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 CPU, extension racks, power supply cards, communication interface cards, I/O cards, etc. interchangeable between the various installed nodes.

Cards and slots shall be mechanically coded to prevent the incorrect card being inserted into a given slot. Alternatively, the controller shall use internal 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 sensor and actuator wiring. 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 IEC 61000-4-5 or similar standard.

The supplier 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.

6 PLC INPUTS/OUTPUTS

All inputs shall have visual status indication on the front of the modules. A maximum of 8 inputs with a single common 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. 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 visual indications. Electromechanical relay outputs shall be capable of performing at least 0,3 million operations with the load specified for AC-15 utilisation category (durability class 0.3) according to IEC 60947-5-1.

For both the input and the output modules the visual indication shall give a true load - side indication to and from the field devices.

Analog input modules shall be of the multiple input range type. This may be either by means of plug-in type measuring range cards, dip-switch selection or software configuration. 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.

Analog 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 the logic circuitry and shall be electrically isolated from each other. Output modules with “Communication Active” indicators are preferred. Isolation in the form of opto isolators shall be provided for all inputs and outputs and the driving logic of the modules.

All outputs shall revert to the fail-safe state when the PLC CPU fails or is switched off or is re-started (i.e. Run mode switched from stop to run)

All inputs and outputs, digital and analog shall be clearly labeled with the relevant I/O tag number. Labels shall be printed in black on white and either inserted in the IO Card connector block or printed on adhesive paper which is then adhered to the IO Card or connector block.

7 DATA COMMUNICATION

The PLC shall be able to communicate with a HMI, SCADA, and with other PLCs via an industry standard, commercially available network protocol. Common, industrial automation protocols include:

PROFIBUS
MODBUS
Industrial Ethernet
ControlNet

A robust and secure network protocol that adheres to a deterministic message passing methodology shall be used.
Network failure shall not affect the operation of the PLC in any way. The PLC shall act on the last received communication information from a device and further generate a fault signaling communications time-out if communications with a device is interrupted for more than 300ms.

Data communications response time on the network shall not exceed 1 second.

Remote programming over the PLC network shall not disrupt the normal flow of PLC communication messages.

All PLC to PLC and PLC to HMI/SCADA communications message blocks shall be clearly documented in the SCADA/PLC FDS (Functional Design Specification) document. Sufficient spare capacity shall be assigned for future message extensions. All message items (status bits and measured value words) shall be uniquely addressed.

8 PLC SOFTWARE GENERAL

The PLC shall be programmed using standard commercially available programming software which complies with the IEC31161-3 standard.

It shall be possible to remotely program the PLC over the communications network via a suitably configured firewall.

All PLC programs shall be stored on CD/DVD ROMS, from which it shall be possible to download onto the PLC on site by means of a programming tool. "Master" and "Back-up" CD/DVD ROMS of all programs shall be issued to the Employer after commissioning.

It shall be possible to modify and/ or update the software in the CPU without disrupting its operation (i.e. on-the-fly updates).

The PLC together with its programming software shall provide an on-line debugging and simulation facility where status of all inputs, outputs and internal registers can be examined and modified for debugging and software testing and acceptance purposes.

9 PLC SOFTWARE PROGRAMMING

PLC software shall be structured efficiently such that overall cycle time shall not exceed 300 milliseconds for general control applications and 30 milliseconds for motion control applications. Cycle time sharing may only be adopted for slow processing Analogs or closed loop controllers. Critical control logic may not be cycle-time shared.

The Contractor shall prepare and submit for approval, a Functional Design Specification explaining how the PLC software will be implemented and how the required control philosophy will be programmed. The Functional Design Specification should include the following as a minimum:

- Software structural breakdown and description
- Equipment modes of operation description
- Tag numbering system (equipment and software)
- Complete device list (sensors, actuators etc.)
- Complete input and output list with physical addresses
- Logic diagrams for control of all devices
- Complete list of all alarms generated within the PLC
- Equipment start-up and shutdown sequences (including flow charts)

- List of registers and timers with default settings
- Complete data communications structure with tags (for HMI and/or SCADA systems)

10 TYPICAL MODES OF CONTROL

The software code in the PLC shall reflect the controlled equipment's wiring control circuit and the Employer's standard modes of control.

Software modules shall operate in two control modes, automatic and manual. The front-end control modules for motors, valves etc. shall be provided with an additional mode
s called maintenance and local modes. The PLC software module shall manage the mode selections so that each module is independently mode managed.

Automatic Mode:
A module that is selected auto shall b e controlled by another software module, e.g. a control sequence, in the next control. Switching to auto mode shall be permissible at all times. All interlocks shall apply in this mode.

Manual Mode:
Manual mode shall only be selected by an Operator, from the HMI or SCADA. All interlocks shall apply in this mode. Manual mode selection shall be permissible at all times. If a manual operation is performed on a module, it shall automatically switch to manual mode. The module shall remain in manual mode until selected back to auto.

Maintenance Mode:
A front end control module can be selected to maintenance mode only when the equipment is de-energised and in manual mode. A sequence cannot run if one or more sub-ordinate modules are selected to maintenance mode. The maintenance selection may also be a 'process' type interlock on upstream equipment. Maintenance mode bypasses all process interlocks. Safety interlocks are still active. A Maintenance Mode request switches equipment between Manual and Maintenance Mode. .

Field Control/Local Mode:

The field control mode allows for the control of equipment from a Field Control Panel situated somewhere in the facility, local to the equipment being controlled. An example of where this field control mode would apply would be when setting the gap on a ventilation fan louver. The hydraulic system would need to be controlled from a field panel.

2.1 Software Blocks

A modular software design shall be adopted. Standard software blocks are to be used for common control equipment such as motors, valves, actuators, measured values, alarms, totalisers, sequence and closed loop controllers.

Motors:
Standard motor control blocks shall be provided for uni-directional and bi-directional direct on-line starters as well as for reactive, soft or variable speed starters.

Motor starts shall be latched and reset on any fault condition. The start-up time shall be monitored and the latch reset if it failed to start within 3(variable) seconds. The latch shall also be reset if the running feedback fails even after initial start-up.

Bi-directional start commands shall be suitably cross interlocked to prevent both commands being issued simultaneously.

A minimum of 8 interlocks will be provided for on the block and faceplate. The interlocks must be able to be bypassed via the faceplate by a person with a suitable user access authority level.

The motor control blocks shall make allowance for starts per hour limitations. The motor control blocks shall also make allowance for the transfer of asset management data e.g. power consumption to higher level MIS systems as required by the FDS.

Valves and Actuators – ON/OFF:
A standard valve control block shall be provided for all discrete open and close type valve actuators with and without feedback.

Where feedback switches are fitted, both valve limits shall be monitored and failed to open or failed to close within time-out 3(variable) seconds shall be reported and logged. Where feedback switches are not fitted, the feedback signal feature shall be disabled on the valve block.

Valve controls shall make provision for continuous open commands on single actuators, which shall be latched, as well as for flapper gate type valves with dual actuators, where a separate open or close command is given. Control logic shall be cross interlocked to prevent both commands being issued simultaneously.

Valve and actuator controls shall include open and close hysteresis to prevent “hunting” or excessive switching of outputs.

A minimum of 8 interlocks will be provided for on the block and faceplate. The interlocks must be able to be bypassed via the faceplate by a person with a suitable user access authority level.

Valves and Actuators - Modulating:
Standard valve control blocks shall be provided for all modulating control valve actuators.

Where feedback switches are fitted, both valve limits shall be monitored and failed to open or failed to close within time-out 3(variable) seconds shall be reported and logged. Where feedback switches are not fitted, the feedback signal feature shall be disabled on the valve block. Optional rotary feedback instrumentation may

be fitted for applications as required. The failure of valve positioning within time-out 3(variable) seconds shall be reported and logged

A minimum of 8 interlocks will be provide
d for on the block and faceplate. The interlocks must be able to be bypassed via the faceplate by a person with a suitable user access authority level.

Measured Values:
Measured value blocks shall be provided for all analog inputs types which will make provision for noise filtering, limit value monitoring, signal line break/ short circuit monitoring and date and time stamping.

All measured values shall be capable of reporting high-high, high, low and low-low values where, high-high or low-low imply emergency limits and high or low imply operational limits. Limits shall operate on measured value hysteresis of typically 2-5 %(variable).

Measured values shall be normalised typically 0-10 000 before being communicated to the SCADA/DCS.

Digital input blocks:

Digital inputs that require minimum on time filtering functionality, to eliminate contact chattering, shall use this module. The functionality of each digital includes the delay time, active & reset of alarms, status & delay signals.

Both positive and negative signal edges are to be delayed, providing delayed signals in phase to the original signal.

Alarms:
Alarm blocks shall be provided for selected analogue inputs/outputs, digital inputs and / or motors, and actuators.

Alarm blocks shall date and time stamp changes in alarm states and provide alarm latching and reset functionality.

Alarm blocks shall make provision for time limit triggered alarms, frequency filtering and alarm overrides or enables.

Totalisers:
Standard software blocks shall be provided for totalising run hours and flows over configurable time intervals or frequencies.

Totalisers shall be reset-able and provide enable and override facilities.

Totaliser values shall be normalized typically 0-10 000 before being communicated to the SCADA/HMI system The SCADA/HMI system shall make provision for a 7 digit totaliser display..

Control Sequences:
Sequential start-up and shut-down shall be achieved by a Sequential Function Chart control language implementing step and transition logic.
A sequence shall be able to be paused, reset or shutdown at any time.

Closed Loop Controllers:

High speed Proportional, Integral and Derivative (PID) closed loop and open loop control software blocks shall be provided. The controller shall allow the configuration of P, I and D components via the SCADA/HMI system and operate in Automatic, Manual or Cascade mode.

Limits on closed loop controllers and failure to maintain closed loop control shall be reported as alarms on the SCADA/HMI system.

It shall be possible to configure controllers for cascade control, ratio control and summation/ difference control purposes.

11 INTERLOCKS

The PLC shall provide for two types of interlocks namely process and safety interlocks.

Process Interlocks:
These are dictated by the physical flow of material through a process and are typically programmed between motor, valve, actuator and controller software blocks.

Equipment being prevented from start-up by a process interlock shall clearly (via 128 character description) indicate this condition on the SCADA/HMI system.

<u>Safety Interlocks:</u>

These are typically hardwired into the motor, valve or actuators control circuit and shall indicate as faults on the SCADA/HMI system.
No process interlocks sequential starts and stops or closed loop control may be programmed elsewhere other than in the PLC.

12 INSTALLATION

12.1 General

The Contractor shall adhere strictly to the recommended mounting, earthing and EMC compatibility requirements of the PLC manufacturer. The Contractor shall ensure that the PLC will not operate at any time outside the environmental limits published by the equipment 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 panel.

If forced ventilation and / or panel heaters are required to provide the climate necessary for the PLC equipment, then this shall be included in the panel design, together with 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 preset values.

A PLC shall always be installed in a panel with a glass window in the door such that PLC and IO status can be clearly observed without having to open the panel doors.

12.2 Equipment Numbering

All PLC’s and associated components e.g. PLC panels, communication transceivers, switches and power supplies shall be labeled by means of an engraved label as per the control system architecture drawing. Attachment of labels and label holders shall not degrade the IP rating of any enclosure.

12.3 Cable core numbering

A commercially available off-the-shelf wire marking system shall be used to label all cables and cores at both ends of the cable in accordance with the wiring diagrams.

13 SCREENING AND EARTHING

<u>Field instrument (sensors) signal screening:</u>

Sensor cable screen conductors, used for grounding unwanted signal noise, will be terminated to an isolated signal screen bar (instrument screen) located in the PLC panel.
An isolated screen bar is a bar that is isolated from the safety earth.

Individual and overall screen wires of all sensor cables shall be terminated at the equipment room side only and shall be left disconnected (floating) and insulated at the sensor in the field.

All single pair cable screen conductors shall be insulated and tied back at the sensor.

Analogue single pair cable screen conductors shall be connected to individual terminals in a junction box.

Overall analogue cable screen conductors and digital cable screen conductors shall be insulated and tied back inside the junction boxes.

Under no circumstances shall the screen conductors be utilised for any other purpose than for noise immunity.

Safety Earthing:

The safety earth (or electrical earth) shall be utilised for safety earthing and equipotential bonding of all metal C&I equipment and support. The earth mat must be certified to less than 1 ohm prior to commissioning.

14 PANEL WIRING

All digital signal wiring shall be multi-strand, minimum 0.75mm², 600V grade PVC insulated copper conductors manufactured in accordance with SANS 1507-3.

All power wiring, including neutral wiring shall be multi-strand, minimum 1mm², 600V grade PVC insulated copper conductors manufactured in accordance with SANS 1507-3.

All data wiring shall be minimum 0.22mm², tinned copper cores, colour coded twisted pairs, and screened cable.

All analogue signal wiring shall be multi–strand, minimum 0.5mm², 300V grade PVC insulated copper cores, twisted pair, screened cable.

DC Power shall be fused on the positive leg by appropriate fuse.

AC Power shall be circuit breaker protected on Live and Neutral legs.

All conductor terminal blocks/rails shall be clearly identified.

NB: Notwithstanding the above, the cross sectional area of all wiring cores shall be calculated to suit the required load capacity.

All conductors shall be supported in PVC trunking to hold all conductors running horizontally and vertically. Trunking shall be sized so that it is at no stage more than 80% full.

Where wires travel from fixed to moveable locations, e.g. from a chassis to a hinged door, the wires shall be bunched together and harnessed by PVC spiral wrapping or braided polyamide sleeving. Harnesses shall be secured on the fixed and moveable section.

Conductors shall be connected by means of single terminal connector blocks only.

Double/Triple stack terminal connector build-form shall not be used.

No ferruled, taped or similar joints shall be made in connecting any conductors.

Commercially available cable and wire marking systems shall be used to identify all cable cores at both ends in accordance with the wiring diagrams. The markers shall be white, 30mm in length, with size 12, black Arial font. The transparent sleeves shall be 30mm in length. The markers shall fit securely, without sliding, over the cable core insulation.
Where cable cores pass through metal holes, non-flammable grommets shall be provided.

Only crimped connector/lugs shall be used. Soldered lugs shall not be accepted. Crimping tools shall be of a type approved by the connector/lug manufacturer.

15 PANEL MOUNTING OF EQUIPMENT

DIN rail mounted components shall be used wherever possible.
All components shall be so fixed that they may be removed and replaced without the aid of special tools. Only fasteners with metric threads shall be used.

Lightweight components (including DIN rail) shall be mounted on the chassis plate by means of holes directly drilled and tapped into the chassis. Galvanised or cadmium plated steel screws shall be used. The use of rivets is prohibited.

Heavyweight components shall be mounted on the chassis plate or cubicle framework either by means of studs welded direct to the chassis or frame, or by means of suitable self-gripping hand bushes with cadmium plated nuts and washers.

Care shall be taken to ensure that instruments and components are rigidly supported and not susceptible to shock or vibration.

16 QUALITY

16.1 Inspection and Method of Testing

The PLC shall be inspected by the Engineer and tested by the Contractor (which tests shall be witnessed by the Engineer) prior to delivery, installation and switch-on at site.

The Contractor shall allow in his tender price for all costs that shall be incurred by himself and/ or the Engineer to perform these inspections and tests. The contractor shall bear all the costs of the Engineer should the test be conducted at a location great than 50km from the Engineer’s office.

The Contractor shall have all equipment available (e.g. paint thickness tester) to do all tests. Any additional equipment required for the tests shall be obtained by the contractor and remains the Contractor’s property.

The Engineer reserves the right to inspect any equipment covered by this Specification at any stage during manufacture.

A test report template shall be submitted with the tender detailing exactly which tests will be made, and how they will be performed. After testing at the Contractor’s offices, one original and one copy of the official test report shall be submitted to the Engineer.

Should the Engineer, when called upon to witness tests and inspections, find that the Contractor has not made reasonably certain that the tests will be successful, he can cancel such tests and postpone them to a future date so that the Contractor can ascertain by pre-testing that the equipment to be tested will be of acceptable standards.

Any such re-test expenses incurred by the Contractor and/or the Engineer shall be borne by the Contractor.

Any equipment or workmanship found by the Engineer to be of inferior quality during construction, erection, commissioning, or during the guarantee periods, shall be replaced promptly to an acceptable quality and standard, at the Contractor's expense.

The final acceptance tests shall be undertaken after completion of the full installation on site.

16.2 Inspections and Tests by The Engineer

Inspections:

The minimum inspection of the PLC, by the Engineer, shall include the following:

Correct choice of PLC CPU and power supply (calculations to be presented)
Correct configuration of all Input and Output Cards (drawings to be presented)

Correct wiring of all expansion/ remote modules (drawings)
Correct wiring of all input and outputs to marshalling strips (drawings)
Code review of all PLC Control Logic (logic diagrams, flowcharts and software printouts to be presented)
Review of the Contractor's Quality Control Documentation (check-lists to be presented)

<u>Tests:</u>

The minimum testing of the PLC system, by the Engineer, shall include the following:

Thin slice testing and acceptance of all software control blocks
Correct operation of all control logic
Correct operation of all modes of operation
Correct detection and annunciation of simulated faults
Correct inter PLC/ SCADA/DCS data communication
PLC cycle time measurement
PLC/ SCADA/DCS data communications response time measurement.

The compulsory method of testing shall be using the actual PLC that will be delivered to site and set up in a simulated environment. Simulation of the process to be controlled shall be as simple and cost effective as possible.

17 DOCUMENTATION

This following documentation shall be provided by the Contractor at the various project phases listed below:

17.1 With Tender

PLC manufacturer's datasheet
Manufacturer's datasheets for all associated components e.g. fibre optic transceivers, communication switches, power supplies and other intelligent hardware

17.2 During Construction

Control system architecture drawing
PLC I/O list
PLC loading calculations
PLC panel General Arrangement drawing
PLC panel schematic/wiring drawings
PLC Functional Design Specification (FDS)
Point to Point wiring check certificates
PLC panel IP certificate
PLC panel Quality Control Documentation certificates
PLC panel Certificate of Compliance and test report

17.3 As Built

Control system architecture drawing
PLC I/O list

PLC loading calculations
PLC panel General Arrangement drawing
PLC panel schematic/wiring drawings
PLC I/O loop drawings
PLC Functional Design Specification (FDS)
PLC Trip and Alarm Matrix

F252 - HUMAN MACHINE INTERFACE (HMI)

1 SCOPE

This part of the standard gives detailed technical specifications which apply to HMI's (Human Machine Interface).

1.1 Normative References

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

IEC 61131 – Programmable Logic Controllers (All parts)

SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

SCADA – Supervisory Control and Data Acquisition

PLC – Programmable Logic Controller

CPU – Central Processing Unit

HMI – Human Machine Interface

I/O – Input/output

DCS – Distributed Control System

SCADA – Supervisory Control and Data Acquisition

2. GENERAL SPECIFICATIONS

HMI's shall be configured to provide operators with a graphical representation of the facility and equipment, status information, alarm lists, graphical trends and general data logging in the absence of a SCADA system OR as a backup up to a SCADA system.

HMI's shall also allow selectable control parameter changes to a PLC which shall be password protected and recorded. Parameters that may be changed shall be as described in the control philosophy of the facility/equipment package.
This standard does not deal with the functional safety or other aspects of the overall automated system. PLCs, their application program and their associated peripherals are considered as components of a control system.

2.1 Climatic Conditions

The HMI shall be suitable for the operating temperature ranges given in Table 1 below.

	Type of Limit	Enclosed Equipment	Open Equipment
Temperature Range	Max	40^0C	55^0C
	Min	5^0C	5^0C

Table 2: Temperature Range

For non-ventilated HMI's that are cooled by natural air convection, the HMI ambient air temperature is the temperature at a point not more than 50 mm away from the HMI, on a horizontal plane located at the vertical mid-point of the HMI.

For ventilated HMI, the HMI ambient temperature is the temperature of the incoming air, at a point not more than 50 mm from the plane of the HMI's air flow entry point.

No forced external cooling is assumed. Open peripherals, which are intended to be permanently installed as part of the system, shall meet the operating temperature range of the HMI.

The HMI shall be suitable for a relative humidity level from 10 % to 95 %, noncondensing.

Conformal coated printed circuit boards and components shall be supplied where the equipment is exposed to the following:

H_2S - Hydrogen sulfide

SO_2, SO_3 - Sulfur dioxide

C_nH_n - Hydrocarbons

NO_x- Oxides of nitrogen

Cl_2 - Wet Chlorine/Dry Chlorine

NH_3 - Ammonia

The conformal coating shall comply with the ISA-S71.04 standard for Class G1, G2 and G3 environments.

2.2 Equipment specification

The HMI shall be of the same manufacturer as the PLC or an approved equivalent which is fully compatible with the PLC.

The unit shall be a dedicated graphic terminal or panel mountable industrial PC (Personal Computer) and shall comply with the following minimum specifications:

ITEM	SPECIFICATION
Type	**Colour LCD (256 colours minimum 65000 preferred)**
Hardware	**Dedicated Hardware**
Size	**10.4” to 17.0”**
Resolution (Pixels)	**Minimum 800 x 600 or better**
Backlight	**CFL (50000hrs at 25deg C and 24hr operation)**
Touch Panel / Screen / Keypad	**40x30 touch grid**
Memory (Flash EPROM)	**8 Mb**
Data Backup (SRAM)	**512 kilobyte**
Interfaces Protocol	**Ethernet IEEE802.3**
Interface Port	**RJ45 respectively**
Sound (for Alarm)	**Built in or separate speaker / buzzer**
Data Transfer	**Via Compact Flash or USB Memory Stick**
Printer Port	**USB 2.0**
Power Supply	**24VDC**
Degree of Protection	**Front -IP 65 ; Rear –IP 20**
Operating Temperatures	**5-50 Degrees C to EN 61131-2, UL compliant**
EMC Compatibility	**To Class A/EN 55022/55011**

The HMI shall be field-proven under similar conditions and shall be suitably protected against excessive temperature, electrical interference, input and output overvoltage or short-circuit.

2.3 Data communication

The HMI shall be able to communicate with a PLC via an industry standard, commercially available protocol e.g. Industrial Ethernet.

Network failure shall not affect the operation of the PLC in any way and messages that would have been sent on the healthy network shall be buffered and re-sent when the network connectivity is restored.

Data communications response time on the network shall not exceed 3 seconds.

Remote programming of the HMI shall not disrupt the normal flow of PLC communication messages.

2.4 Configuration

The HMI shall be configured with graphic displays (mimics) showing all pertinent equipment, its status (running, tripped or stopped) and instantaneous instrument readings. Graphics shall be configured using standard objects from a well-developed symbol library.

Mode selection on controlled devices (e.g. valves/louvers) shall be clearly indicated on the HMI.

A means for navigation shall be provided from where an operator can navigate from the overview to detailed mimics for the installed equipment under control.
Status shall be indicated by different state colours (such as White for Ready, Green for Running, Amber for Tripped and Red for E-stop). Where status is indicated by different state colours, these colours shall be consistent with those used to configure other monitoring systems.

A trending screen shall be provided showing all measured value readings over time. The trend page shall show live and historical data (which shall be recorded in the HMI memory in a first in first out rolling log file). Trends shall be configured to show an hourly/shift/daily interval of readings.

An alarm page shall be provided showing all outgoing and incoming alarms. Alarms shall also be stored in a first in first out file stored in the HMI memory. It shall be possible to scroll backward and forward in the alarm list.

Contextual help pages shall be provided and shall be called up at will by the Operator or automatically by the PLC associated with the HMI on a specific state or alarm condition.

The HMI shall be configured via a software development tool provided with the HMI by the Contractor. This software tool shall be delivered to the client at the end of the contract together with all relevant licenses and manuals.

If the HMI is a panel mount industrial PC with disk based operating system (such as MS Windows CE) and a propriety graphic interface is not provided, a recognized SCADA package may be installed on the HMI in which case the full requirements of the SCADA Specification part of this specification shall apply.

2.5 Typical Modes of Control

The software code in the HMI shall reflect the controlled equipment's wiring control circuit and the Employer's standard modes of control.

Software modules shall operate in two control modes, automatic and manual. The front-end control modules for motors, valves etc. shall be provided with an additional mode
s called maintenance and local modes. The PLC software module shall manage the mode selections so that each module is independently mode managed.

<u>Automatic Mode:</u>
A module that is selected auto shall be controlled by another software module, e.g. a control sequence, in the next control. Switching to auto mode shall be permissible at all times. All interlocks shall apply in this mode.

<u>Manual Mode:</u>
Manual mode shall only be selected by an Operator, from the HMI or SCADA. All interlocks shall apply in this mode. Manual mode selection shall be permissible at all times. If a manual operation is performed on a module, it shall automatically switch to manual mode. The module shall remain in manual mode until selected back to auto.

<u>Maintenance Mode:</u>

A front end control module can be selected to maintenance mode only when the equipment is de-energised and in manual mode. A sequence cannot run if one or more sub-ordinate modules are selected to maintenance mode. The maintenance selection may also be a 'process' type interlock on upstream equipment. Maintenance mode bypasses all process interlocks. Safety interlocks are still active. A Maintenance Mode request switches equipment between Manual and Maintenance Mode. .

<u>Field Control/Local Mode:</u>
The field control mode allows for the control of equipment from a Field Control Panel situated somewhere in the facility, local to the equipment being controlled. An example of where this field control mode would apply would be when setting the gap on a ventilation fan louver. The hydraulic system would need to be controlled from a field panel.

2.6 Installation

2.6.1 General

The Contractor shall adhere strictly to the recommended mounting, earthing and electromagnetic shielding requirements of the HMI manufacturer. The Contractor shall ensure that the HMI 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 HMI shall be taken into consideration when designing the panel.

If forced ventilation and / or panel heaters are required to provide the climate necessary for the HMI, then this shall be included in the panel design, together with climate monitors to inform the operator in the control room when the equipment is operating in undesirable conditions.

2.7 Quality

2.7.1 Inspection and Method Of Testing

The HMI shall be inspected by the Engineer and tested by the Contractor (which tests shall be witnessed by the Engineer) prior to delivery, installation and switch-on at site.

The Contractor shall allow in his tender price for all costs that shall be incurred by himself and/ or the Engineer to perform these inspections and tests. The Contractor shall bear all the costs of the Engineer should the test be conducted at a location greater than 50km from the Engineer’s office.

The Contractor shall have all equipment available to do all tests. Any additional equipment required for the tests shall be obtained by the contractor and remains the Contractor’s property.

The Engineer reserves the right to inspect any equipment covered by this Specification at any stage during manufacture.

A test report template shall be submitted with the tender detailing exactly which tests will be made, and how they will be performed. After testing at the System Integrators offices, one original and one copy of the official test report shall be submitted to the Engineer.
Should the Engineer, when called upon to witness tests and inspections, find that the Contractor has not made reasonably certain that the tests will be successful, he can cancel such tests and postpone them to a future date so that the Contractor can ascertain by pre-testing that the equipment to be tested will be of acceptable standards.

Any such re-test expenses incurred by the Contractor and/or the Engineer shall be borne by the Contractor.

Any equipment or workmanship found by the Engineer to be of inferior quality during construction, erection, commissioning, or during the guarantee periods, shall be replaced promptly to an acceptable quality and standard, at the Contractor's expense.

The final acceptance tests shall be undertaken after completion of the full installation on site.

2.7.2 Inspections and Tests

<u>Inspections:</u>

The minimum inspection of the HMI, by the Engineer, shall include the following:

Correct choice of HMI and power supply
Correct configuration of all HMI graphics, alarms and trend pages (drawings to be presented)

Correct wiring (drawings)
Review of the Contractor’s Quality Control Documentation (check-lists to be presented).

Tests:

The minimum testing of the HMI system, by the Engineer, shall include the following;

- Correct operation equipment
- Correct operation of all modes of operation
- Correct graphics, alarm and trend operation
- Correct inter PLC/ SCADA data communication
- PLC cycle time measurement with HMI connected
- PLC/ SCADA data communications response time measurement
- Correct trends setup
- Correct alarms setup
- Correct user access level setup

The preferred method of testing shall be using the actual HMI that will be delivered to site and set up in a simulated environment. Simulation of the process to be controlled shall be as simple and cost effective as possible.

2.7.3 Documentation

This following documentation shall be provided by the Contractor at the various project phases listed below:

2.7.4 With Tender

HMI manufacturer’s datasheet
Manufacturer’s datasheets for all associated components e.g. fibre optic transceivers, communication switches, power supplies and other intelligent hardware

2.7.5 During Construction

Control system architecture drawing
HMI panel General Arrangement drawing
HMI panel schematic/wiring drawings
Functional Design Specification (FDS)
Point to Point wiring check certificates

HMI panel IP certificate
HMI panel Quality Control Documentation certificates
HMI panel Certificate of Compliance and test report

2.7.6 As Built

Control system architecture drawing
HMI panel schematic/wiring drawings
Functional Design Specification (FDS)
Point to Point wiring check certificates
HMI panel IP certificate
HMI panel Quality Control Documentation certificates
HMI panel Certificate of Compliance and test report

F254 - ELECTRONIC INSTALLATION

1. SCOPE

This part of the standard gives detailed technical specifications which apply to the installation of PLC's (Programmable Logic Controllers) and HMI's.

1.1 Normative References

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

IEC 61131 – Programmable Logic Controllers (All parts)

c) SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations
d)

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

SCADA – Supervisory Control and Data Acquisition
PLC – Programmable Logic Controller
CPU – Central Processing Unit
HMI – Human Machine Interface
I/O – Input/output
DCS – Distributed Control System
SCADA – Supervisory Control and Data Acquisition

2. GENERAL

The following sections details specifications related to the installation of PLC's and HMI's.

2.1 Equipment numbering and marking

Equipment shall be marked with a manufacturer's data plate specifying, where applicable, the following:

- Manufacturer's Name
- Model and Serial Number
- Power supply requirement
- Tag number

2.2 Cable Numbering and Marking

The Contractor shall produce a cable schedule from which all cable identification numbers will be derived.

Cables shall be labeled with the cable number at the origin and destination points and at entries / exits to racking / ducting / penetrations, by means of a label, approved by the Engineer, suitably attached to the cable. The cable marking label shall be finished with a "fit-for-purpose' plastic sleeve, approved by the Engineer, suitably attached to the cable.

3. FIELD MOUNTED BOXES LABELLING AND WIRING

The Contractor shall produce a 'junction box/panel schedule' from where all field-mounted box identification numbers shall be derived.

Field boxes shall be identified by means of an engraved label.

Environmentally suitable label holders shall be used such that labels can be removed without damage to the box.

Attachment of label holders shall not degrade the IP rating of the box.

The box identification plate shall specify, where applicable, the following:

- Panel Number
- Equipment/Panel Service
- Network/Control System Unique Identification

4. CABLE CORE MARKING

A wire marking system shall be used to identify all cable cores at both ends in accordance with the wiring diagrams.

5. SCREENING AND EARTHING

Sensors cable screen conductors, used for grounding unwanted signal noise, will be terminated to an isolated signal earth bar (instrument earth) located in the PLC panel or Remote IO panels. An isolated earth bar is an earth bar that is isolated from the safety earth and connected to generation origin earth.

Individual and overall screen wires of all sensor cables shall be terminated at the equipment room side only and shall be left disconnected (floating) and insulated at the instrument in the field.

All single pair cable screen conductors shall be insulated and tied back at the sensor.

Analogue single pair cable screen conductors shall be connected to individual terminals in a junction box. Overall analogue cable screen conductors and digital cable screen conductors shall be insulated and tied back inside the junction boxes.

Under no circumstances shall the screen conductors be utilised for any other purpose than for noise immunity.

The safety earth (or electrical earth) shall be utilised for the safety earthing of all metal automation equipment and supports.

6. FIELD MOUNTED BOXES

PLC panel's degree of protection shall be suitable for environmental condition of installation according to IEC 529 and EN 60529 (1991).

- PLC panels shall be epoxy coated mild steel or other material as dictated by the installation environmental conditions and specifications.

- Locking shall be of the three point locking type.
- Door handle shall be suitable for padlocking.
- The box shall be numbered.
- All digital signal wiring shall be SABS approved stranded, minimum $0.75mm^2$, 200V grade PVC insulated conductors.
- All power wiring, including neutral wiring shall be SABS approved stranded, minimum $1mm^2$, 600V grade PVC insulated copper conductors.
- All data wiring shall be SABS approved stranded, minimum $0.22mm^2$, tinned copper cores, twisted pair, screened cable.
- All analogue signal wiring shall be SABS approved stranded, minimum $0.75mm^2$, 200V grade PVC insulated tinned copper cores, twisted pair, screened cable.
- DC Power shall be fused on the positive leg by appropriate fuse.
- AC Power shall be circuit breaker protected on Live and Neutral legs.
- All conductor terminal blocks/rails shall be clearly identified.
- Notwithstanding the above, the cross sectional area of all wiring cores shall be calculated to be “fit for purpose”.
- All wires shall be supported in PVC trunking to hold all conductors running horizontally and vertically. Trunking shall be sized so that it is at no stage more than 80% full.
- Where wires travel from fixed to moveable locations, e.g. from a chassis to a hinged door, the wires shall be bunched together and harnessed by PVC spiral wrapping or braided polyamide sleeving. Harnesses shall be secured on the fixed and moveable section.
- Conductors shall be connected by means of single terminal connector blocks only.
- Double/Triple stack terminal connector build-form shall not be used.
- No ferruled, taped or similar joints shall be made in connecting any conductors.
- Cable and wire marking systems shall be used to identify all cable cores at both ends in accordance with the wiring diagrams. The markers shall be white with black. The markers shall fit securely, without sliding, over the cable core insulation.
- Where cable cores pass through metal holes, suitable non-flammable grommets shall be provided.
- Only crimped connector/lugs shall be used. Soldered lugs shall not be accepted. Crimping tools shall be of a type approved by the connector/lug manufacturer.

- DIN rail mounted components shall be used wherever possible.
- All components shall be so fixed that they may be removed and replaced without the aid of special tools. Only fasteners with metric threads shall be used.
- Lightweight components shall be mounted on the chassis plate by means of holes directly drilled and tapped into the chassis. Galvanised or cadmium plated steel screws shall be used.
- Heavyweight components shall be mounted on the chassis plate or cubicle framework either by means of studs welded direct to the chassis or frame, or by means of suitable self-gripping hand bushes with cadmium plated nuts and washers.
- Care shall be taken to ensure that instruments and components are rigidly supported and not susceptible to shock or vibration.

7. CABLES AND CABLE CORES

- All cables shall comply with the relevant SANS specification for the particular type of cable.
- Outer insulation material of cables for installation in confined spaces shall be fire retardant, non-toxic and Halogen free.
- All cables shall be tested prior to delivery to site. The tests shall establish that the cables' dielectric is sound, that all cores are continuous from end to end, and that it complies with the cable schedule details and the manufacturer's specifications.
- The cross sectional area of all cable cores shall be calculated to be "fit for purpose".
- Unused or spare cable cores shall be strapped together with cable straps should they not be connected to spare terminals.
- The length of spare cores shall exceed the length of the longest used core.
- Consistency in the use of core colours and / or numbers shall be maintained throughout the installation to avoid confusion.
- Colour and / or number coding of cores shall be shown on the relevant drawings.
- Cores passing through holes in chassis or screens shall be fully protected by correctly fitted grommets or bushes.
- Cores carried across a hinged portion of a chassis or door shall be flexible. Sufficient slack shall be provided to obviate tension.
- The insulation of a core shall not be stripped back further than or less than necessary. The conductor shall not be exposed with a crimped insulated terminal lug fitted.

- Not more than one core shall be connected to one side of a connection terminal block.
- Core terminations shall be fitted with interlocking engraved (black letters on white background) plastic cable ferrules, reference numbered to correspond with the related schematic or wiring diagrams. Split or clip-on ferrules or adhesive marking tapes are not acceptable. The markings for horizontal runs shall be from left to right when facing them, and for vertical runs from the bottom upwards.
- The wiring inside panels and junction boxes shall be well planned and neatly arranged in the best possible manner, allowing for forming of cores so that there is no strain on them.

8. SIGNAL CABLE INSTALLATION

- Cables shall be installed neatly, either saddled or strapped to the panel or supporting steelwork. Where this is not possible or practical, the cable loom shall be strapped together using proprietary type plastic cable straps available for this purpose. Cotton insulation or thread shall not be used.
- Cables shall be secured and connected at terminations so as to prevent undue mechanical stresses upon glands, conductors or terminals.
- Signal and communication cables shall be segregated and separated from power cables on separate racking, parallel routes shall be separated by a minimum distance of at least 300mm, space permitting and if physically possible.
- Cables shall not be installed double-banked on racks.
- Armoured cables shall be secured to racks or angle-iron supports by 10mm wide stainless steel strapping and purpose-made buckles.
- Unarmoured cables shall be secured to racks or supports by fit for purpose PVC or nylon cable straps.
- The span of strapping shall be such as to prevent bunching of cables, and in any event should not exceed 1000mm.
- Cables running horizontally on cable racks mounted vertically (edgewise) shall be secured to cable racks at 600mm intervals, which shall be reduced as necessary to prevent unsightly sagging of cables.
- Cables laid flat in racks parallel with a slightly inclined ground or floor surfaces need not be secured to the racks more often than is necessary to prevent cables from walking as a consequence of expansion, contraction or vibration.
- Any horizontal or vertical cable run that are not strapped or supported in such a way that the cable cannot fall in the event of fire shall be strapped by 10mm wide stainless steel strapping and purpose-made buckles at 1 meter intervals.

- Holes for cables passing through panel steelwork shall be made smooth or bushed to prevent severing of the cable and fitted with appropriate grommets.
- Joints in cables are prohibited unless the route lengths exceed the maximum lengths the manufacturer can supply. In this eventuality, approved proprietary types of junction boxes shall be used. Joints shall only be used with approval from the Employer.
- When stripping insulation from cores, the conductors shall not be nicked or cut.
- All conductors shall be terminated in an insulated double crimped termination lug of the correct size using a crimping tool approved by the manufacturer of the terminal.
- Bare conductor terminations shall not be accepted.
- Pin lugs shall be used for connections using terminal strips and spade lugs when terminating under a screw head.
- Holes into air-conditioned rooms shall be completely sealed off to maintain the air conditioning system performance.
- Cable screens at the unearthed end of the cable are to be tied back and covered with heat-shrink sleeve. Cable screens shall not be cut off at the cable sheath.
- Cables shall enter an enclosure from the bottom and shall be formed to relieve stress on the cable end, with a sealing boot fitted over the cable gland.
- Cables to instruments shall be terminated in a locally mounted approved three way bottom entry IP65 connection box (as per current mine standard) with a short length (1 to 2 meters) of flexible cable with a single 150mm diameter loop strapped to a suitably supported angle iron.
- The connection box can be multiple-way units to accommodate more than one loop, provided the loops are associated. A terminal strip shall be fitted inside the box for core connections.
- Sealing boots shall cover the cable glands fitted to connection boxes.

9. COMMUNICATION CABLE INSTALLATION

Bus cables should ideally be installed in their own steel cable channels or conduits. If not installed in conduit bus cables should be brightly colored and installed where they are clearly visible and separate from all other cables in order to improve any interference pickup and to avoid accidental damage.

When installing, it is important not to distort or damage bus cables since this can cause reflections to occur in the network. In particular, do not twist or stretch bus cables, do not quash or crimp them and adhere to the recommended minimum bend radius (typically for solid core: 75mm minimum. For stranded cables: 45mm for a single bend and 65mm for repeated bending).

To reduce the chances of interference pickup, it is important that bus cables are run separately from other types of cable. It is useful to categorise various cable applications as follows:

Category I:
- Fieldbus and LAN cables (e.g. PROFIBUS, AS-I, Ethernet)
- Shielded cables for digital data (e.g. printer, RS232)
- Shielded cables for low voltage (≤25V) analogue and digital signals.
- Low voltage power supply cables (≤60V).
- Coaxial signal cables

Category II:
- Cables carrying DC voltages >60V and ≤400 V
- Cables carrying AC voltages >25V and ≤400 V

Category III:
- Cables carrying DC or AC voltages >400 V
- Cables with heavy currents.
- Motor/drive/inverter cables.
- Telephone cables (can have transients >2000V).

Category IV:
- Cables of categories I to III at risk from direct lightning strikes (e.g. connections between components in different buildings)

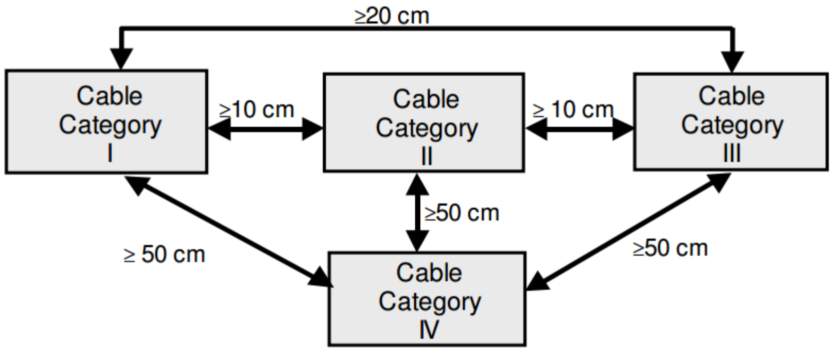


Figure 1: Separation Distances

Where cables have to cross, they should cross at right angles and should never run in parallel even for short distances.

Cables from the same category can be bundled together or laid directly beside each other in the same cable trays. Cables of different category must be separated by at least 10cm.

When separated by earthed steel partitions with a steel lid, the bundles can be placed next to each other. All channels and partitions must be properly earthed using flexible bonding links protected against corrosion. Note that braided straps are better than solid metal for high-frequency EMC protection.

The braided shields of all communication cables entering the wiring closet should be earthed with metal clamps as close as possible to the point of entry to the cabinet.

10. OPERATING AND MAINTENANCE MANUALS

Comprehensive sets of Operations and Maintenance manuals shall be supplied for the automation works. The manuals shall be supplied in electronic and also hardcopy bound formats and shall include the following minimum content:

a) Contents/index pages
b) P&ID's
c) Instrument list
d) PLC FDS
e) HMI FDS
f) Standard Operating procedures describing automatic and manual operations
g) Routine inspection procedures
h) Fault conditions identification
i) Faultfinding procedures
j) Equipment manuals
k) Instrument calibration datasheets
l) Listing of parts and spares lists
m) Cable and connector datasheets
n) Listing of all software licenses

The Index of the O&M Manual format shall be as follows:

Volume 2: Automation Works

- APPROVED FOR CONSTRUCTION P&ID'S
- INSTRUMENT LIST
- PLANT CONTROL PHILOSOPHY
- CONTROL SYSTEM NETWORK TOPOLOGY DRAWING
- PLC
  - FDS
  - I/O LIST
  - OPERATING INSTRUCTIONS
  - FAULT-FINDING INSTRUCTIONS (THIS IS THE CONTRACTOR'S DELIVERABLE SPECIFIC TO THE INSTALLATION)
  - MAINTENANCE INSTRUCTIONS (THIS IS THE CONTRACTOR'S DELIVERABLE SPECIFIC TO THE INSTALLATION)
  - ALL DRAWINGS

- 2.6 HMI
  - FDS
  - OPERATING INSTRUCTIONS
  - FAULT-FINDING INSTRUCTIONS (THIS IS THE CONTRACTOR'S DELIVERABLE SPECIFIC TO THE INSTALLATION)
  - MAINTENANCE INSTRUCTIONS (THIS IS THE CONTRACTOR'S DELIVERABLE SPECIFIC TO THE INSTALLATION)

- 2.7 SCADA
  - FDS

    - OPERATING INSTRUCTIONS
    - FAULT-FINDING INSTRUCTIONS (THIS IS THE CONTRACTOR’S DELIVERABLE SPECIFIC TO THE INSTALLATION)
    - MAINTENANCE INSTRUCTIONS (THIS IS THE CONTRACTOR’S DELIVERABLE SPECIFIC TO THE INSTALLATION)

- UPS
    - OPERATING INSTRUCTION MANUAL
    - FAULT-FINDING INSTRUCTIONS (THIS IS THE CONTRACTOR’S DELIVERABLE SPECIFIC TO THE INSTALLATION)
    - MAINTENANCE INSTRUCTIONS (THIS IS THE CONTRACTOR’S DELIVERABLE SPECIFIC TO THE INSTALLATION)

- FIELD INSTRUMENTATION
    - INSTRUMENT LIST
    - INSTRUMENT DATASHEETS
    - INSTRUMENT CALIBRATION SHEETS
    - INSTRUMENT LOOP DRAWING
    - INSTRUMENT MAINTENANCE INSTRUCTIONS (SPECIFIC TO PROJECT)

- CABLES
    - CABLE BLOCK DIAGRAM
    - CABLE SCHEDULE
    - CABLE DATASHEETS
    - CABLE TEST CERTIFICATES

- COC'S
    - PLC PANELS

- FAT'S
    - PLC
    - HMI
    - SCADA
    - FIELD INSTRUMENTATION

- MANUFACTURER’S OPERATING AND MAINTENANCE MANUALS
    - PLC MANUFACTURER’S OPERATING, TECHNICAL AND MAINTENANCE MANUALS
    - SCADA MANUFACTURER’S OPERATING, TECHNICAL AND MAINTENANCE MANUALS
    - HMI MANUFACTURER’S OPERATING, TECHNICAL AND MAINTENANCE MANUALS
    - UPS MANUFACTURER’S OPERATING, TECHNICAL AND MAINTENANCE MANUALS
    - FIELD INSTRUMENTATION OPREATING, TECHNICAL AND MAINTENANCE MANUAL

- SOFTWARE
    - HMI SYMBOL LIBRARY AND SOFTWARE CONFIGURATION
    - HMI AND PLC APPLICATION SOFTWARE BACKUP
    - HMI AND PLC PROGRAMMING SOFTWARE
    - PLC BLOCK LIBRARY ANDSOFTWARE CONFIGURATION
    - PLC FDS IN ELECTRONIC FORMAT
    - HMI FDS IN ELECTRONIC FORMAT
    - SCADA FDS IN ELECTRONIC FORMAT
    - SCADA SYMBOL LIBRARY AND SOFTWARE CONFIGURATION
    - SCADA APPLICATION SOFTWARE BACKUP
    - ALL WORKSTATION AND SERVER OPERATING SYSTEM MEDIA

- ALL SOFTWARE LICENSES AND DONGLES

F255 - FUNCTIONAL DESIGN SPECIFICATION (FDS)

1. SCOPE

This part of the standard specification gives detailed technical specifications which apply to the development and presentation of Functional Design Specifications applicable to automation systems.

2. NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

IEC 61131 – Programmable Logic Controllers (All parts)

SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations

ISA 88 – Batch Control (All parts)

ISA 95 – Enterprise – Control System Integration (All parts)

ISA 99 – Security for Industrial Automation and Control Systems (All parts)

ISA 5.1 – Instrumentation Symbols and Identification

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

SCADA – Supervisory Control and Data Acquisition

PLC – Programmable Logic Controller

CPU – Central Processing Unit

HMI – Human Machine Interface

I/O – Input/output

DCS – Distributed Control System

SCADA – Supervisory Control and Data Acquisition

FDS– Functional Design Specification

3. GENERAL

A Functional Design Specification is a document that describes (in words and diagrams) the configuration and programming of an automation system based on the automation system and process control requirements. It is compiled by the Contractor and approved by the Engineer before bulk coding begins. There may be instances where certain aspects of the FDS is required to be tested in order to limit project risks – these tests shall be done during the thin slice testing phase of the software configuration.

4. FORMAT

A Functional Design Specification format shall comply with the format below:

4.1 Control System General

4.1.1 Introduction

4.1.2 Control System Configuration i.e. (a detailed drawing of how SCADA and PLC are arranged and interconnected)
(Drawing of how SCADA and PLC are arranged and interconnect)
4.1.3 Equipment Tag Numbering Convention
(Table or Drawing)
4.1.3 Software Tag Numbering Convention
(Table or Drawing)
4.1.4 Controlled Equipment
1.4.1. Motor List
(Include detail that says whether it’s a DOL, VFC, SS and additional protection e.g. MPR)
1.4.2 Instrument List
(Include detail describing type, make model, range, interface etc.)
4.1.5 Control Philosophy
(I.e. the Consultant's control philosophy as modified by the mechanical contractor to suit the system being supplied)
4.1.6 Start-up and Shutdown Sequences (if applicable)
(Clearly described with all step and transition information)
4.1.7 Control Loops (if applicable)
(Clearly described with PV, CV and theoretical values for P, I & D parameters)
4.1.8 General control philosophies and rules, command handling
4.2.9 Status and alarming (first-up alarms, alarm rules, alarm layers and alarm definition flow)
4.2.10 Modes of Control (Automatic, Manual. Maintenance, Bypass etc.)
4.2.11 Interlock types i.e. primary, secondary. Hold, wait, safety interlocks etc.

4.2 SCADA

4.2.1 SCADA Configuration (showing all servers, operation stations, firewalls, switches, cables etc.)
(More detail than the general diagram if required)
4.2.2 SCADA Hardware
(Make, Model, part numbers etc. right down to component level)
4.2.3 SCADA Networks
4.2.4 Communications Tasks
(Describe protocols, protocol configuration, computer names, PLC drivers etc.)
4.2.5 Data Communications Structures
(Clear description on how the SCADA fetches information from the PLCs and the actual TAG Lists)
4.2.6 SCADA Software Package(s)
4.2.7 Operating System
4.2.8 SCADA Package (Type, Name, Version, Tag count etc.)
4.2.9 Database System (Type, Name Version)
4.2.10 Reporting Software
4.2.11 Remote access
4.2.12 Folder Structure (i.e. for the configuration files specification to this contract)
4.2.13 SCADA Features
4.2.14 Modes of Operation
4.2.15 Mimic Displays (include screen mock-ups)

4.2.16 Mimic Dynamic Graphic Symbols
(Include symbol mock-ups with clear documentation describing all logic and decision making behind them)
a) Motors
b) Valves
c) Analogs

d) Controllers
e) Sequences
f) Totalizers

4.2.17 Equipment Display Faceplates

(Include symbol mock-ups with clear documentation describing all logic and decision making behind them)

a) Motors
b) Valves
c) Analogs
d) Controllers, P&ID, Cascade, ratio controllers etc.
e) Sequences
f) Totalizers

4.2.18 Historical and Real-Time Trending

(Describe scanning, scanning frequency, logging, log file location, include screen mock-ups etc.)

4.2.19 Alarm and Event Management

(Describe in detail, how these are generated cleared, logged etc., include screen mock-up)

a) Alarm hierarchy
b) Priority
c) Alarm grouping (alarm lists)

4.2.20 System Reports

(Describe in detail, how these are generated, run, stored etc., include screen mock-up)

4.2.21 Operator Access Security Model

(Essentially a copy from the contract specification)

4.2.22 System Back-up and Storage

(Describe how this is done automatically, manually, all procedures, include screen grabs)

4.2.23 Operational data storage (of machine)

- Structure (tables)
- Period

5. PLC

5.1 PLC Configuration

(Describe in detail, right down to rack layout, PSU, CPU, IO arrangement, IO communications).

5.2 PLC Hardware

(Make, Model, types etc.)

5.3 PLC Networks

(Describe protocol, message blocks, timing etc., if required)

5.3.1 Communications Tasks

5.3.2 Data Communications Structures (TAG Lists)

5.3.3 Communication protocols

5.4 PLC Software General
(Programming language, version etc. Also describe how the code is structured and in what order the program is processed, cycle time etc.)

5.5 PLC Inputs and Outputs
(Include a complete list with addresses)

5.6 PLC Software Structure

5.6.1 Modes of Operation
(Essentially a copy of the Contract Specification)

5.6.2 Software Function Blocks / Code Blocks
(Describe in detail, include printouts and logic diagrams, parameter descriptions etc.)

a) Motors
b) Valves
c) Analogs
d) Controllers
e) Sequences
f) Totalizers

5.6.3 Interlocks (Process and Safety)
(I.e. list them clearly)

5.6.4 Safe Start Warnings

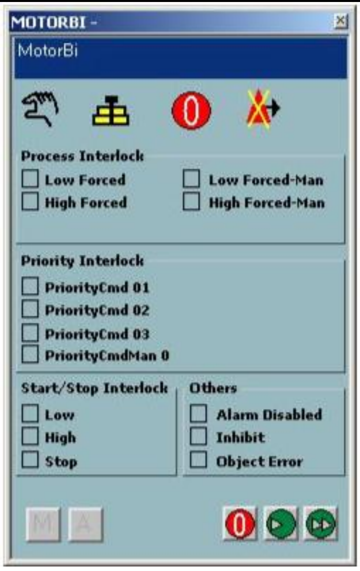
5.7 System Back-up and Storage
(Describe how the PLC software should be backed up, restored etc.)

APPENDICES TO BE INCLUDED

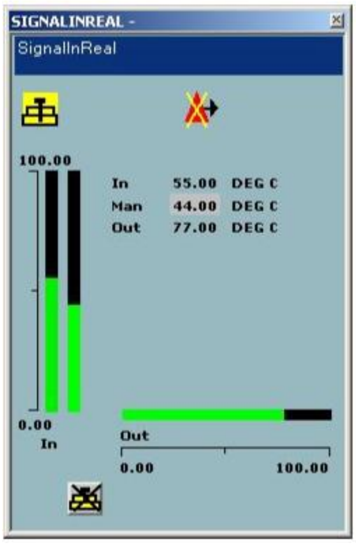
HMI, SCADA Screen grabs, Displays, Tag lists etc.
PLC Code Flowcharts, Code Listings, Logic Diagrams, IO Lists etc.

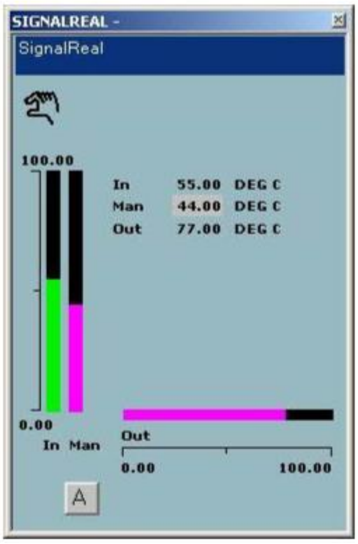
5.8 Examples of HMI and SCADA Faceplate configurations

<u>Drives:</u>

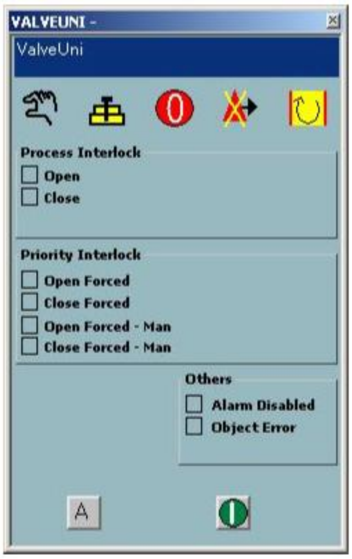


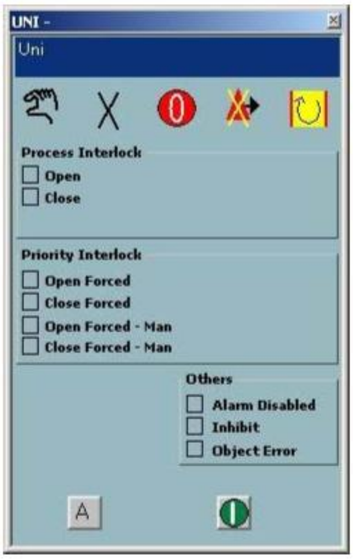
Analogs:



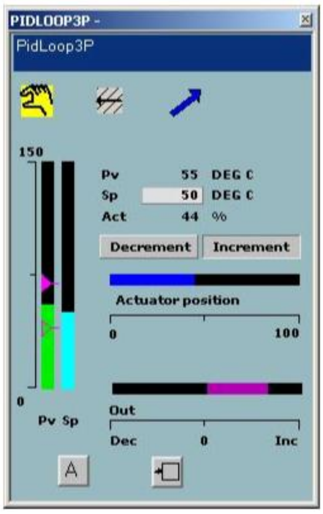


Valves:





PID Loops:



F257 - STANDARD SPECIFICATION FOR FIELD INSTRUMENTATION

1. SCOPE

This part of the standard specification gives detailed technical specifications which apply to field instrumentation. This specification does not apply to field instrumentation applied within Safety Instrumented Systems or within classified, hazardous areas.

2. NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition

of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

ISA-5.1 – Instrumentation symbols and identification

ISA-5.4 – Instrumentation loop diagrams
ISA-7.0.01 – Quality standard for instrument air
ISA-20 – Instrumentation forms for process measurement and control instruments
ISA-71.01 – Environmental conditions for process measurement and control systems: temperature and humidity
ISA-71.02 – Environmental conditions for process measurement and control systems: Power
ISA-71.03 – Environmental conditions for process measurement and control systems: Mechanical Influences
ISA-71.04 – Environmental conditions for process measurement and control systems: Airborne Contaminants
ISA-75.01 – Control Valve Sizing Equations
SANS/IEC 60529 – Degrees of protection provided by enclosures (IP code)
SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations

3. DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

I to P – Current to Pressure
NPT – National Pipe Thread
BSP – British Standard Pipe Thread
FSD – Full Scale Deflection
NP – Nominal Pressure
DCS – Distributed Control System
SCADA – Supervisory Control and Data Acquisition

4. GENERAL

The Contractor, supplier and vendor of all instrumentation shall operate a Quality Assurance system based on the principles of ISO 90001 or equivalent. This Quality System shall be subject to auditing and monitoring by the Engineer or his representative.

Only proven instrumentation, which is readily available with the region of operation and widely used in similar applications shall be supplied.
All field mounted equipment, junction boxes, etc. including entries and blanking plugs shall have an environmental protection rating of IP65.

Hardware shall be field-proven under similar conditions and shall be protected against excessive temperature, electrical interference, input and output overvoltage or short-circuit.

The supplier 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.

All instrumentation type pipe fitting shall be compliant with the mechanical detailed specifications for the project.

The Tenderer shall, in his price submission, provide for the cost of any tools and other specialist items required operating and maintaining the instrument.

5. TECHNICAL DOCUMENTATION APPLICABLE TO INSTRUMENTATION

The instrumentation symbols and presentation on the P&ID’s shall be in accordance with the ISA S5.1 standard, inclusive of all tag numbering.

Instrumentation data sheets shall be produced by the Contractor for all instrument types. The datasheets shall completely identify the instrument by type and model number and shall indicate operating data such as range, capacity, action and set-point.

Calculations shall include, but not limited to, the sizing of orifice plates, flow elements, control valves, relief valves etc. All calculations shall be performed in accordance with the international standards and codes. Control valve calculations shall be completed to the selected supplier's formulae, including noise calculations. Care must be taken to ensure that the noise levels shall not exceed 85dBA.

6. INSTALLATION

Field installed cable glands for instrumentation shall be of the double compression type and have an ingress protection of IP65. The glands are to seal on the inner and outer sheaths and clamp on the metal armoring.

Instrumentation cable screens shall run continuously from each instrument through the cable junction boxes to the insulated instrument earth bar mounted in the control system panel. The screen shall be connected at the instrument side only.

All field instrumentation and junction boxes shall be bonded to earth using 2.5 mm^2 minimum conductor size earth cables.

7. CLIMATIC CONDITIONS

The equipment shall be suitable for the operating temperature ranges given in Table 1 below.

e) **Type of Limit**	f) **Enclosed Equipment**	g) **Open Equipment**
h) **Max**	i) 40^{0}C	j) 55^{0}C
k) **Min**	l) 5^{0}C	m) 5^{0}C

n) Table 3: Temperature Range

Conformal coated printed circuit boards and components shall be supplied where the equipment is exposed to the following:

- H2S - Hydrogen sulfide
- SO2, SO3 - Sulfur dioxide/trioxide
- CnHn - Hydrocarbons
- NOx- Oxides of nitrogen
- Cl2 - Wet Chlorine/Dry Chlorine
- NH3 - Ammonia

The conformal coating shall comply with the ISA-S71.04 standard for Class G1, G2 and G3 environments.

8. P&ID GENERAL STANDARDS

Please refer to F260 for detailed specifications pertaining to P&ID's.

The columns listed below shall be used as the standard PID layering convention with the line thicknesses is for reference purposes only. This convention is based on an original drawing size for P&ID's of size A0.

Name	Colour	Line Thickness	Description
Layer 1	Green	0.7mm	Equipment & Major process lines
Layer 2	Magenta	0.35mm	New major pipelines

Layer 3	Red	0.5mm	Minor Process Lines
Layer 4	Yellow	1.0mm	Major Process lines
Layer 5	Grey	0.12mm	Arrows & Borders
Layer 6	White	0.25mm	General
Layer 7	Cyan	0.25mm	Text & Utility Lines
Layer 8	Blue	0.35mm	Borders

When P & ID's are plotted to smaller sizes, line thicknesses shall be adjusted accordingly.

The following scaling parameters shall be used:

Item	Description	Value
1	Text height	2.5
2	ID Bubble Radius	8
3	Instrument Mark Spacing	12
4	Global Scale Factor	10
5	Snap Value	2.5

Scalable symbols should be scaled proportionally to these items when inserted.

A0 shall be the standard size on which a P&ID is to be developed. For convenience, they may be plotted on smaller sizes, but all P & ID's plotted to the original size, should yield the same result in respect of scaling and sizing of equipment.

Standard symbols shall be used for all symbols depicted on drawings:

9. P&ID TAGGING CONVENTIONS

Area codes:

The following area coding convention shall be used throughout the site:

Example:

F	A	A

FAA where

F is the plant description
A is the area location
A (third letter) denotes the stream description

A complete list of area codes shall be developed for the project.

Equipment numbering convention:

The following numbering convention shall be used:

Example:

o) FAA	p) -	q) PMP	r) -	s) 001

TGA-PMP-001 where

FAA is the area code
PMP is the equipment Identification code
01 is a sequential number

A complete list of equipment codes will be developed for the project.

Line numbering convention
The following line numbering convention shall be used on all P&ID drawings:

Example:

t) 25	u) -	v) PW	w) -	x) CS	y) -	z) 001

25-PW-CS-001 where
25 is the nominal pipe size
PW is the product code
CS is the pipe material code
001 is a sequential number

A complete list of pipe product and material codes will be developed for the project.

Mechanical valve numbering convention
The following numbering convention shall be used:

Example:

aa) FAA	bb) -	cc) HV	dd) -	ee) 001

FAA-HV-001 where

FAA is the area code
HV is the valve code
001 is a sequential number

A complete list of valve codes will be developed for the project.

Instrument Tag numbering convention
The instrumentation tag numbering convention used in this specification is based on the ISA 5.1 standard and also uses the mechanical equipment number that the instrument is attached to.

Example:

FAA	-	PMP	-	LSL	-	001	

AAA-PMP-LSL-001A where

FAA is the area identification code
PMP is the mechanical equipment number
LSL is instrument identification letter as defined by the ISA standard
001 is a sequential number
A, B, C, D denotes the number of similar instruments within the same loop

Electrical Equipment Tag numbering convention

The following electrical equipment tag numbering convention shall be used.

Example:

ff) FAA	gg) -	hh) PMP	ii) -	jj) MCC	kk) -	ll) 001	r

AAA-LSL-8301A where

FAA is the area identification code
PMP is the mechanical equipment number
MCC is electrical identification code letter
001 is a sequential number
A, B, C, D denotes the number of similar electrical equipment within the same loop

Motor Control Equipment and I/O Tagging Convention

The following shall be used in conjunction with the motor control equipment number for the identification of motor control equipment on P&ID's:

Motor Controlled Equipment	
MCD MCV	Motor Control Drive (DOL) Variable Speed Drive
MCS	Soft Starter

The following shall be used in conjunction with the motor control equipment number for the identification of motor control I/O:

Digital Inputs	
A	Healthy
B	Running
C	Remote/Local
D	Tripped
E	Fault
Digital Outputs	
F	Start
G	Stop
H	Reset
Analog Inputs	
I	Speed Feedback
Analog Outputs	
J	Speed Reference
Information Tags	
K	Number of Starts
L	Operating Hours

Instrument LOOP numbering convention

The following instrument loop numbering convention shall be used:

Example:

TGA	-	D	n	PMP	001

TGA-D-00.80 where

TGA is the process area code
D is the first letter of the instrument function and
PMP001 is the mechanical equipment number that the instrument is associated with

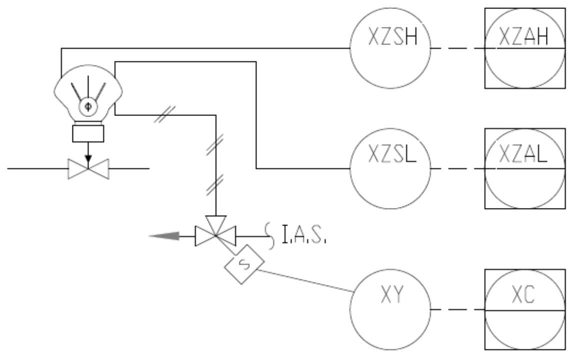
Instrument bubbles

The following is required configurations with respect to instrument bubbles depicted on P&ID's:

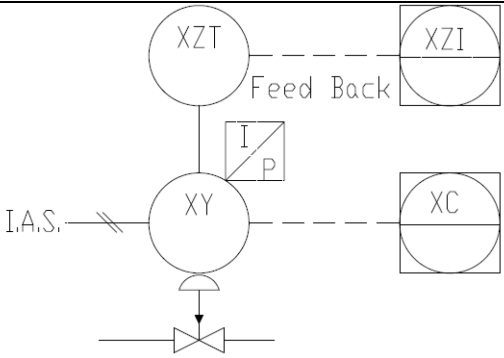
- The area code must be displayed as part of the instrument bubble.
- Multiple instruments of the same type will be indicated by a suffix A, B, C, etc. and all will require their individual bubbles.
- It is imperative that each and every instrument, even these mounted on local control panels, be indicated on the P&ID.
- Instruments on local control panels will be indicated by the bubble with double lines through it. These instruments mounted on the same panels, will be grouped by a dash-dot line around them.
- Solenoid valves are tagged as XY. 'X' has been inserted to assist in the creation of loop numbers, enabling the solenoid valve to group with the limit switches.
- Position switches for valves are tagged as ZSH (open) and ZSL (closed).

10. P&ID TYPICAL CONFIGURATION

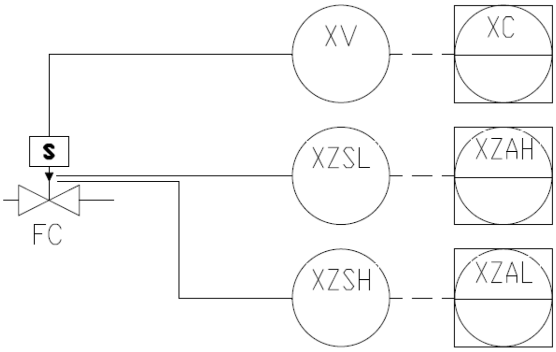
Rotary Actuator – Single Acting:



Modulating Control with Feedback:



Solenoid Valve with Open/Close Feedback:



11. MECHANICAL PRESSURE MEASUREMENT (GAUGE)

General

a) Gauges shall operate on the Bourdon tube principle.

Design

a) Gauges shall be 100mm nominal diameter unless stated otherwise.
b) Gauges used on pressure regulators and I to P's, etc. shall be 50mm nominal diameter.
c) Pressure element, case and all moving parts shall be of stainless steel construction.
d) Dial shall be aluminium, white with black lettering.
e) The pointer shall be aluminium, black.
f) Gauge shall be suitable for liquid/glycerine filling if application requires.
g) The gauge shall be 'laminated safety glass'
h) A pressure vent shall be incorporated into the case design.
i) Environment protection shall be at least IP65 as per IEC 60529.
j) Process connection shall be ½" BSP male bottom or rear entry to suit application. Gauges used on regulators, etc. shall be ¼" BSP connections.
k) Gauges for use on "dirty" of viscous liquids shall be fitted with a diaphragm type chemical seal.

Performance Specifications

a)	Over pressure range	:	1,3 x full scale
b)	Upper limit of range for static pressure	:	75% FSD
c)	Upper limit of range for fluctuating pressure	:	66% FSD

d) Temperature fluctuation : Max ± 0.4% of FS

Installation

a) The pressure gauge installation shall include an isolation valve for safe isolation and removal of the gauge for maintenance purposes.
b) Limits for operating values shall be marked using tamper-proof methods

12. DIAPHRAGM/CHEMICAL OR REMOTE TYPE SEALS

General

a) A chemical seal shall be used on a pressure gauge, pressure or flow transmitter when the flowing media is hot, viscous, and corrosive or contains suspended solids.
b) The seal shall be specifically selected for the medium, pressure range and temperature suitable for the application.

Design

c) The unit shall have a stainless steel body, bolting and diaphragm.
d) The wetted part diaphragm shall be selected to suit the application.
e) Unit pressure rating shall be NP10 or higher as application dictates.
f) Seals and filling liquid shall be suitable for temperatures from 0 to 150 ºC.
g) Process and instrument connections shall be ½" BSP or NPT or flanged as specified in the detailed mechanical specification ***.
h) Seal diaphragms must be able to withstand twice the maximum pressure range of the system to which it is connected and be corrosive resistant to the process medium.
i) Where diaphragm seals require capillary extensions, the capillary shall be 316 stainless steel and be shielded by flexible stainless steel tubing with a neoprene or PVC cover.
j) Length of the capillary shall suit the application, but should be at least 1, 0 m. For differential pressure applications the capillary tubing shall be the same length.

Installation

a) The replacement of the lower body shall be possible without having to carry out modifications to the diaphragm seal system.
b) To avoid pressure peaks, a shut-off valve shall be incorporated.
c) Care shall be taken to ensure that capillary extensions are free from ‘kinks’.

13. PRESSURE TRANSMITTERS

General

d) Transmitter shall be indicating, electronic type based on piezoresistive principle.
e) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand held calibrator or by software application to which the device is networked.
f) Transmitter shall be fitted with a 4-line LCD on-site display. The display shall be show the measured value as well as provide a means to access and set configuration parameters.

Design

Sensor Type	:	Piezoresistive, metallic membrane
Wetted parts	:	316 Stainless Steel
Body material	:	316 Stainless Steel
Process Connection	:	½" BSP
Wetted Parts	:	316 Stainless Steel
Body/Housing material	:	316 Stainless Steel
Process Connection	:	½" BSP
Electrical Connection	:	Gland, M20

Electronics Housing Protection : IP65
Overpressure Limit : 200% of maximum process static pressure
Mounting : Pipe stand or direct process connection
Output : 4-20 mA, HART into 250Ω load
Supply : 9 to 32VDC (loop powered)
Calibration Adjustments : Independent Zero and span
Process Temperature : -25 to + 55°C
Ambient Temperature : -25 to + 55°C
Humidity Limits : 5 - 80% RH

Performance

Accuracy : 0.1% of span or better
Repeatability : 0.05% of span
Response Time : <250ms
Vibration : 3 to 25 Hz: ±1.6 mm (0.063 in);
25 to 100 Hz: 4 g in all 3 axes

Ambient Temperature effect : not to exceed 0.5% of maximum span/10° C change
Turndown ratio : 20:1

14. DIFFERENTIAL PRESSURE TRANSMITTERS

General

a) Transmitter shall be of the compact, indicating, electronic type based on piezoresistive principle.
b) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand held calibrator or by software application to which the device is networked.
c) Transmitter shall be fitted with a 4-line LCD on-site display. The display shall be show the measured value as well as provide a means to access and set configuration parameters.

Design

Sensor Type : Piezoresistive, metallic membrane
Wetted parts : 316 Stainless Steel
Body material : 316 Stainless Steel
Process Connection : ½" BSP
Electrical Connection : Gland, M20
Electronics Housing Protection : IP65
Overpressure Limit pressure : 200% of maximum process static
Mounting : Pipe stand or direct process connection
Output : 4-20 mA, HART into 250Ω load
Supply : 9 to 32VDC (loop powered)
Calibration Adjustment : Independent Zero and span
Process Temperature : -25 to + 55°C
Ambient Temperature : -25 to + 55°C
Humidity Limits : 5 - 80% RH

Performance

Turndown ratio : 20:1

Accuracy	:	0.1% of span or better
Repeatability	:	0.05% of span
Response Time	:	<250ms
Vibration	:	3 to 25 Hz: ±1.6 mm (0.063 in);

25 to 100 Hz: 4 g in all 3 axes

Ambient Temperature effect	:	not to exceed 0.5% of maximum span/10° C change

15. THERMOWELLS

General

a) Thermowells shall be provided for all temperature measuring elements that are inserted into process vessels and process pipes.
b) The tips of thermowells in pipes shall be situated in the third of the pipe. Care shall be taken to ensure that the wake frequency is less than the natural frequency of the well.
c) Always install the thermowells where there is fast movement of the gas or fluid to be measured in order to avoid the effects of coating.
d) Thermowells shall be installed within pipe elbows (to ensure maximum immersion) or a at a 45° angle to the pipe.

Specification

Material	:	316 Stainless Steel or process compatible
Internal Diameter	:	8 mm nominal
External Diameter	:	10 mm nominal
Process Connection	:	½" BSP male
Temperature Element Connection	:	½" BSP female
Insertion length	:	To DIN 43772

16. THERMOCOUPLES

General

a) Thermocouples shall be used for temperature measurement where the temperature range exceeds 200°C.
b) Ensure that the length is selected to permit good thermal contact at the tip of the couple with the end of the well.

Specification

Sensor Type	:	Application dependant
EMF Output to Temperature Relationship	:	According to tables in BS1829
Diameter	:	6 mm nominal OD
Performance	:	± 2°C up to 300° C
Vibration resistance	:	50g peak to peak
Response time	:	<5s

17. RTD'S

General

a) RTDs shall be used where greater accuracy than thermocouples is required.
b) Ensure that the length is selected to permit good thermal contact at the tip of the couple with the end of the well.

Specification

Type	:	PT 100 3 wire simplex mineral insulated
Diameter	:	6mm nominal OD

Resistance/Temperature Relationship	:	As per BS1904 Table 1 Rev 1979
Accuracy	:	± 0.5% of span, or better
Repeatability	:	± 0.1% of span
Dead Band	:	Not to exceed 0.1% of span
Ambient Temperature effect	:	Not to exceed 0.5% of span per 10°C change
Vibration resistance	:	50g peak to peak
Response time	:	<5s

18. FILLED SYSTEMS

General

a) The filled systems shall be all welded, including the bulb and capillary tube.
b) Maximum temperature shall not exceed 300°C; over-range shall be minimum 50%.
c) Filled systems shall not be used on shutdown services.

Specification

Maximum length	:	3 m.
Accuracy	:	1% of span or better.

19. MECHANICAL TEMPERATURE GAUGES

General

a) The gauge shall be either a bimetal helix coil type or a gas filled system as appropriate for the application.

Design

a) The gauges shall be 150 mm nominal diameter unless stated otherwise. Viewing angle shall be adjustable.
b) Case material shall be stainless steel.
c) Dial shall be white with black lettering and marked in degrees centigrade.
d) The element shall be 8 mm nominal diameter with a length to suit the application.
e) Capillary tube where application demands.
f) Gauge shall be furnished with a pre-fabricated stainless steel thermowells which shall have a process connection of ½" BSP male and a bulk connection of ½ BSP female.
g) A zero-point adjustment shall be incorporated into the back of the instrument.

Performance

Accuracy	:	± 1% of span
Response time	:	1,2 x maximum span

20. TEMPERATURE TRANSMITTERS

General

a) The temperature transmitter shall be electronic type with connections for a 3-wire RTD/thermocouple type connection.
b) The unit shall comprise of a head mounted transmitter and an integral element (unless the Project Specification calls for a different arrangement).

Transmitter

Mounting	:	Head mounted, encapsulated unit
Ambient Temperature limitations	:	70°C
Humidity Limits	:	0-100% relative humidity
Power Supply	:	24V DC (loop powered)
Output	:	4-20 mA, HART into 250Ω load

Burnout Facility	:	Upscale or downscale option
Calibration Adjustments	:	Independent zero and span
Input	:	To suit sensor type

Head

Material	:	Aluminium
Protection Class	:	IP65
Electrical Connection	:	M20 entry for gland fitting

21. ORIFICE PLATES

General

a) Flange tappings shall be used.

Design

a) The design shall comply with BS 1042 Part 1 1984, or ISO 5167.
b) Material shall be 316 stainless steel unless process conditions dictate otherwise.
c) The direction of flow, the orifice size and the tag number shall be stamped into the lug (handle) of the orifice plate. This information shall be clearly visible when the O/P is in service.
d) The straight length of upstream and downstream pipe work run for the installation shall be 10D and 5D respectively (minimum).
e) No connections shall be made in either the upstream or downstream straight pipe work.
f) Sizing calculations for the orifice plates shall be furnished to the Engineer prior to manufacture.

Performance

a) The accuracy of each individual installation shall be determined and corrections for the thermal expansion of the plate, the adiabatic expansion of the fluid (if applicable) and the drain hole (if applicable), shall be applied.
b) The determination of head loss shall be calculated.

22. VENTURIES

General:

a) The Venturi may be used to measure the flow of liquids and slurries that are not too abrasive. They may be used in applications where the requirement for greater accuracy or lower pressure loss is justified by the higher expense, compared to an orifice plate.
b) The differential pressure is measured using a standard DP cell.

Design:

a) The design shall comply with ES1042 Part 1 1984 or ISO 5167.
b) Material shall be stainless steel, unless the process conditions dictate otherwise.

Performance:

a) Data sheets provide the information required to perform the calculations and the tolerances permitted.
b) Accuracy : ± 0.75% of full scale

23. FLOW NOZZLES

General:

a) A nozzle may be considered for applications requiring higher flow rates or greater accuracy than an orifice plate. Applications are more suited to gases and clean liquids, especially those that discharge from the pipe to atmosphere.
b) The differential pressure is measured using a standard DP cell.

Design:

a) The design shall comply with BS1042 Part 1 1984, or ISO 5167.
b) Material shall be stainless steel, unless the process conditions dictate otherwise.

Performance:

a) Data sheets provide the information required to perform the calculations and the tolerances permitted.
b) Accuracy : ± 1% of full scale

24. DALL TUBES

General:

a) The Dall tube may be considered where lower pressure loss and lower cost at the expense of accuracy, is required, and compared to the Venturi.
b) The differential pressure is measured using a standard DP cell.

Design:

a) The design shall comply with ES1042 Part 1 1984, or ISO 5167.
b) Material shall be stainless steel, unless the process conditions dictate otherwise.

Performance:

a) Data sheets provide the information required to perform the calculations and the tolerances permitted.

Accuracy : ± 1% of full scale

25. DIFFERENTIAL PRESSURE TRANSMITTERS

General

a) Transmitter shall be of the compact, indicating, electronic type based on piezoresistive principle.
b) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand held calibrator or by software application to which the device is networked.
c) Transmitter shall be fitted with a 4-line LCD on-site display. The display shall be show the measured value as well as provide a means to access and set configuration parameters.

Design

Sensor Type	:	Piezoresistive, metallic membrane
Wetted parts	:	316 Stainless Steel
Body material	:	316 Stainless Steel
Process Connection	:	½" BSP
Electrical Connection	:	Gland, M20
Electronics Housing Protection	:	IP65
Overpressure Limit pressure	:	200% of maximum process static
Mounting	:	Pipe stand or direct process connection
Output	:	4-20 mA, HART into 250Ω load
Supply	:	9 to 32VDC (loop powered)
Calibration Adjustment	:	Independent Zero and span
Process Temperature	:	-25 to + 55°C
Ambient Temperature	:	-25 to + 55°C
Humidity Limits	:	5 - 80% RH

Performance

Turndown ratio	:	20:1
Accuracy	:	0.1% of span or better
Repeatability	:	0.05% of span
Response Time	:	<250ms
Vibration	:	3 to 25 Hz: ±1.6 mm (0.063 in);

25 to 100 Hz: 4 g in all 3 axes

Ambient Temperature effect	:	not to exceed 0.5% of maximum span/10° C change

26. ELECTROMAGNETIC FLOW METERS

General

a) Transmitter flow tubes shall operate on the law of electromagnetic induction principle. They shall be of the compact type and suitable for field mounting taking all manufacturer protection guidelines and specifications into consideration.
b) The flow meter shall be suitable for use in pipelines that are cathodically protected.
c) The flow meter shall be supplied complete with all flanges, gaskets and earthing rings.
d) A primary head simulator shall be offered as an option.
e) Empty pipe detection shall be included as a standard function
f) Field excitation shall be pulsed AC or D.C. AC pulsed exciting shall be used for pulsating flow, media with low conductivity and media with high percentage of solids.

Specifications

Connection flange rating : To suit pipeline pressure rating
Connection flange material : Or Ni Steel - depending on application
TubeMaterial : (1, 4301) - depending on application
Liner Material : PFA, Polyurethane rubber, soft natural rubber, EPDM, PTFE (Teflon) or ceramic depending on application i.e. chemical resistance and temperature limitations
Electrode Material : 316SS, Hastelloy, Tantalum, Platinum/Iridium or Titanium depending on application temperature and estimated corrosion rate
Meter Casing : Stainless steel
Power Supply : 24V DC or 220V AC
Enclosure Class : IP65 or IP 68 depending on application
Ambient Temperature Range : Application dependant
Electrical Connections : M20 entry for cable glands
Installation : Flanged

Signal converter

a) Transmitter electronics shall be either head mounted or remotely mounted depending on application.
b) The ingress protection rating of the converter shall be the same as for the primary element, typically IP65 or IP 68, unless a remotely mounted converter is used. In this instance the converter shall be installed in an Instrument panel with an IP rating of IP65
c) Transmitter shall have microprocessor based electronics with local flow indication and ability to display and change, on-line, range and units.
d) The low-flow cut-out shall be user configurable.
e) Parameter and data storage shall be kept in non-volatile memory.

f) Output shall be 4 to 20mA, isolated. Where transmitters have dual ranges, each range shall have a separate output.
g) Totalizer pulsed output shall be maximum 10 pps with a minimum pulse width of 50ms.

Specifications

Accuracy : 0.5% of span over a velocity range > 0.5ms
0.025% of span over a velocity range < 0.5ms
Repeatability : 0.1% of span
Ambient temperature effect : 0.01% per °C changes
Minimum sensitivity : 5 uS/cm
Turndown ration : 1:1000

27. VORTEX FLOW METERS

General

a) Vortex shedding meters shall operate by detecting eddies shed by a bluff body inserted into the stream to be measured, where the number of vortices shed by the bluff body are proportional to the flow rate.
b) Vortex precession (Swirl meters), when used, are used primarily on clean gas services. A fixed impeller sets up the swirl, which is detected by a sensor. The number of "swirls" is proportional to flow rate. Since it has lower tolerances than the Vortex Shedding meter, and is expensive, it is not used.

Specifications

Connecting flange rating	:	To piping specification
Connecting flange material	:	Carbon steel
Meter body material	:	304 Stainless steel
Trim	:	316 stainless steel

Signal Converter

a) Transmitter electronics shall be either head mounted or remote mounted depending on application.
b) Transmitter shall have microprocessor based electronics with local flow indication and ability to display and change on/line, range and units.
c) Electrical connection : 20 mm ISO
d) Output from amplifier : 4 to 20mA, linear

Specifications

Accuracy	:	± 0, 5% FS over the normal flow range
Repeatability	:	± 0, 15%

28. TURBINE FLOW METERS

General

a) Turbine meters shall consist of meter housing with a rotor in the flow stream. The angular velocity of the rotor shall be detected by a magnetic follower, which in turn drives a mechanical counter.
b) All meters shall be delivered complete with a facility to pick up the flow rate pulses for conversion into an electrical signal for transmission to a remote destination. The electrical signal shall be 4 to 20 mA for flow rate plus an impulse with minimum pulse width of 50 ms and maximum rate of 10 pps for remote totalizing. The converters shall be suitable for either local mounting or at a remote location.
c) Compound meters may be used where higher accuracy is required over the full range of flow.
d) Re-ranging of the output shall be possible without major disassembly.
e) The meter shall be installed as per the manufacturer’s recommendations of minimum up- and down-stream runs. 3 - 5 pipe diameters are required if the flow is laminar. Straightening vanes shall be used if necessary.

Design

Accuracy	:	2% over normal flow range 5% over the low portion of the range
Connecting flange rating	:	To piping specification
Connecting flange material	:	Carbon steel
Meter body material	:	Cast iron with corrosion resistant lining

Performance

Accuracy	:	± 0, 5% over the normal flow range
Linearity	:	± 0, 5% over the normal flow range
Repeatability	:	± 0, 5% at any point on the normal flow range

29. POSITIVE DISPLACEMENT FLOW METERS

General

a) The Positive Displacement meter shall consist of a volumetric metering mechanism in the flow stream, with a local totalising indicator coupled to the mechanism. Remote indication or totalisation shall be done, if required, by a transmitter. The output of the transmitter shall accurately reflect the input pulses representing volumetric units of flow.
b) For accounting applications, accurate compensation for temperature shall be included.
c) A suitable strainer/filter shall be installed upstream to protect the meter.

Design

a) Transmitter electronics shall be either head mounted or remote mounted depending on application.

b) Transmitter shall have microprocessor based electronics with local flow indication and ability to display and change on/line, range and units.
c) Output shall be 4 to 20mA.

Performance

a) Typical accuracy shall be 0, 25% FS.
b) Typical repeatability shall be 0,05%

30. OPEN CHANNEL FLOW METERS

General

a) The flow of liquids in open channels shall be measured by means of either weirs or flumes.
b) The variable head at the weir/flume shall be detected by either capacitance level or an ultrasonic sensor located upstream, clear of the effects of drawdown. Other level-measuring principles, such as the bubbler, may be considered.

Design

a) The design, location and materials for the weir or flume shall be determined by the application, and in accordance with BS 3680, Part 4.
b) Pre-constructed weirs and / or flumes shall be manufactured to the specific standard for the application, and correctly installed at the site.

Weirs

a) Ensure that the nappe has sufficient clearance under maximum flow conditions.
b) Where floating debris exist, broad crested weirs shall be used, unless a suitable debris trap is installed upstream of the weir. Flumes shall be considered.
c) The geometry of the weir shall be selected to suit the application and the expected flow rate.
d) Long-base weirs may be used for river flow measurement where construction of flumes may be impractical.

Flumes

a) Flumes may be selected where there is insufficient fall to permit unobstructed downstream flow from a weir.
b) Flumes may be used where silting at a weir may be a problem, or where floating debris is a problem.
c) The geometry of the flume shall be selected to suit the application.
d) The surfaces shall be smooth, especially near the throat.
e) The structure shall be rigid and watertight, and capable of withstanding flood conditions.
f) Uniform approach of flow is required. The approach channel shall be in the order of 5 times the width of the channel in full flow.

Specifications

Accuracy's	:	Rectangular thin-plate weirs	:	1% to 4%
Broad-crested weirs	:	3% to 5%		

"V" notch weir (20° to 100°	:	1% to 2%
Triangular profile weirs	:	2% to 5%
Standing-wave flumes	:	2% to 5%.

31. ULTRASONIC TRANSMITTERS FOR OPEN CHANNEL FLOW METERS

Transducers

a) Suitable support brackets shall be supplied for the ultrasonic transducers.
b) Integrated temperature sensor for automatic correction of sound time of flight.

Specifications

Enclosure	:	IP65
Membrane	:	Stainless Steel
Electrical Connection	:	M20 cable entry for glands
Max Operating Temperature	:	60°C

Transmitter

a) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand-held calibrator.
b) The ability of the system to be configured to ignore unwanted signals from obstructions is essential.
c) 4-line LCD for measuring value viewing and set-up required.

Specifications

Enclosure	:	To suit application
Output	:	4-20mA, HART into 250Ω load
Power Supply	:	24V DC
Calibration Adjustments	:	Independent for Zero & span
Accuracy	:	1% of span or better
Resolution	:	1mm
Repeatability	:	0, 2% of span
Dead Band	:	<0, 2% of span
Ambient Temperature Effect	:	<0, 5% of maximum span per 10°C change

32. CAPACITANCE TYPE ‘FLOW’ METER

General

a) This section covers capacitance rods in the open channel located in a gauge well or settling chamber.
b) A counter-electrode shall be supplied and installed into the gauge well.
c) Rods shall be of a material that is compatible with the process media. Coatings, such as Teflon, shall be used to protect the rods in most applications.
d) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand-held calibration.

Probe

Material	:	Stainless steel
Sheath	:	PTFE
Insertion Length	:	To suit application

Transmitter

Enclosure	:	To suit (IP65)
Output	:	4-20 mA into a 250Ω load
Power Supply	:	24 V DC
Calibration adjustment	:	Independent for Zero & span

Performance

Accuracy : 1% of span or better
Repeatability : 0.2% of span
Dead Band : <0.2 % of span
Ambient temp, effect : < 0.5% if maximum span per 10°C change

33. CLAMP-ON ULTRASONIC FLOW METERS

General

a) Clamp on flow meters shall operate on the time of flight principle. The unit shall be self-contained and shall be battery or mains powered.

Design

Sensors : 2 ultrasonic sensors
Clamping arrangement : The sensors shall be equipped with clamps to enable the sensors to be mounted onto pipes with DN 50 - 3000 mm.
Pipe material : Metal, Plastic, Ceramic, Fibre Cement and internally and externally coated pipes.
Power Supply : Internal batteries, 231VAC, 24VDC, 12VDC
Carrying Case : Aluminium IP54 rated (if the installation is temporary)
Ambient Temperature : -10 to +50°C
Totalizer Pulses : Maximum 10pps with minimum pulse width of 50ms
Flow Cut-off : User configurable

b) The meter shall be equipped with a local LCD display and shall also have an output of 4 - 20 mA. The meter shall have on board logging facilities and printer. The logged data shall be available to a PC via an RS232 link. The software required for the PC interface shall be supplied with the meter.

Specifications

Accuracy : 1% of measured value
Repeatability : 1% of measured value
Temperature stability : < 0.5% of span per 10°C change

34. VARIABLE AREA FLOW METERS

General

a) Rotameters shall be provided for low flow rates if local indication is required. Rotameters shall also be provided if the rangeability, nonlinearity, viscosity, or hazardous nature of the fluid makes a differential-pressure type instrument unreliable. Rotameters shall have line class block valves upstream and downstream for maintenance.

Design

a) A safety-glass indicating tube shall be provided for pressure below 1000 Kpa and temperatures below 100°C. An armoured tube with magnetic pickup shall be provided for other applications. Armoured meter tubes shall have internal guides.
b) All wetted parts of rotameters on high pressures shall be stainless steel. Teflon or other liner materials shall be considered for corrosive fluids.

c) The manufacturer's standard tube and float shall be supplied to provide a normal flow rate between 40 and 80 percent of the meter capacity. The anticipated minimum and maximum flow rate shall be between 10 and 90 percent of the meter capacity.
d) Rotameters shall be accurate within ± 2% of the full scale and shall have direct reading indicating scales or percentage scales with stainless steel factor tags. Indicating scales shall have full length safety glasses with shields and gaskets on both sides. If percentage scales are used, the scale factor shall be tagged on the rotameters.
e) Rotameters shall have beaded, ribbed or flat tube indicators. Plain tempered tubes are not acceptable.
f) Variable area rotameters shall be completely assembled prior to shipment.
g) Rotameters shall be installed vertically

35. MASS FLOW METERS

General

a) A systems approach to mass flow of liquids is to correct volumetric flow by density. A "flow computer" receives signals from volumetric flow meters and density meters, and mathematically generates the mass flow. Other physical characteristics like temperature, viscosity and pressure may be taken into consideration, depending on the accuracy required.
b) Dedicated mass flow meters, using the Coriolis principle, can determine the mass flow directly.

Design

a) Wetted parts shall be Titanium, unless the application demands another material.
b) The transmitter shall be an intelligent microprocessor device, with multiple 4 to 20mA outputs. Customer defined constants shall be configurable, such as display units, pulse outputs, low flow cut-outs and time constants.
c) Optical (Infra-red) vibration sensors are preferred.

Performance

Accuracy	:	± 0.01 % fsd, or
	:	± 0.2% of reading
Repeatability	:	± 0.005% fsd, or
	:	± 0.1% of reading

36. BUBBLER TYPE LEVEL TRANSMITTER

General

a) Bubblers shall operate on the principle that the back-pressure required to maintain a flow of bubbles in a liquid is representative of the level of liquid in an open vessel.
b) The back-pressure shall be measured by a DP-Cell transmitter.
c) Care shall be taken that the dip-tube is adequately supported and clear of any obstructions.
d) Diaphragm type level transmitters shall be used in difficult or hazardous applications, where the level is inferred from the differential pressure.

Design

a) The immersed end of the dip-tube shall be cut at an angle of 45° and with a minimum of 150 mm base clearance.
b) Dip-tube material to be 3/8" OD 316 stainless steel tube. (Depending on media compatibility)

Diaphragms

a) The diaphragms shall be chemical seal devices, connected to the differential pressure transmitter by filled capillary tubes.

37. ULTRASONIC TYPE LEVEL TRANSMITTER

Transducers

a) Support brackets shall be supplied for all types of ultrasonic transducers.
b) Coatings shall be applied to exposed surfaces that may be subject to damage from the process.
c) Alternative mounting methods (e.g.: suspension) may be required in some applications.

Specifications

Process Connection	:	Flange mounting, or to suit
Enclosure	:	IP68
Membrane	:	Stainless Steel
Electrical Connection.	:	20mm entry for cable gland
Max Operating Temp.	:	60°C

Transmitters

a) The transmitter shall comprise of a remote electronics unit and a single field mounted ultrasonic emitter/sensor.
b) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand-held calibrator.
c) The transmitter shall have the ability to linearise the output depending on the geometry of the vessel, and thus relate the output to either level or volume.
d) The ability of the system to be configured to ignore unwanted signals from obstructions or agitators is required.

Specifications

Enclosure	:	To suit application
Output	:	4-20 mA, HART into 250Ω load
Power Supply	:	24V DC
Calibration Adjustments	:	Independent for Zero & span
Accuracy	:	1% of span or better
Repeatability	:	0.2% of span
Dead Band	:	<0.2% of span

Ambient Temperature Effect : <0.5% of maximum span per 10°C

38. CAPACITANCE TYPE LEVEL TRANSMITTERS

General

a) Where non-conductive vessels are used, a counter-electrode shall be supplied and installed into the tank.
b) Rods shall be of a material that is compatible with the process media. Coatings, such as Teflon, shall be used to protect the rods in most applications. The structure and physical attributes of the coatings shall not change due to changing process temperatures.

Specifications (Probe)

Material	:	Stainless steel
Sheath	:	PTFE
Insertion Length	:	To suit application
Process Connection	:	1½" B.S.
Temperature	:	Maximum process temperature 150°C
Pressure	:	Maximum process pressure 1000 Kpa

Specifications (Transmitter)

Enclosure	:	To suit (IP55)
Output	:	4-20 ma into a 250Ω load
Power Supply	:	24V DC
Calibration adjustments	:	Independent for Zero & span

Performance

Accuracy	:	1% of span or better
Repeatability	:	0.2% of span
Dead Band	:	<0.2% of span
Ambient temp. effect	:	<0.5% of maximum span per 10°C change

39. NUCLEAR TYPE LEVEL TRANSMITTERS

General

a) No work shall proceed until the Contractor and the End User (Owner) have satisfied all the regulations governing the handling and transport of nuclear sources. All installations shall be clearly marked with the approved Radiation Warning signs.
b) Temperature compensation for processes that vary in temperature shall be provided as a standard feature.
c) Heaters shall be provided for detectors subject to wide temperature variations.
d) Transmitter electronics shall be either local or suitable for mounting in a cabinet or panel, depending on the application.

Design

a) The source holder shall be fitted with a lockable shutter to permit safe maintenance when required.
b) Mounting brackets shall be secure and corrosion resistant.
c) The detector shall be suitable for mounting on vessels that are cathodically protected.

Performance

a) Power supply shall be either 220vAC or 24vDC.
b) Output signal shall be 4 to 20mA
c) Accuracy shall be 1% full scale or better.

40. DIFFERENTIAL PRESSURE TYPE LEVEL TRANSMITTER

General

a) Transmitters shall be indicating, electronic type based on the capacitance measurement principle.
b) Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand held calibrator.

Specifications

Element Type	:	Diaphragm
Wetted Parts	:	316 Stainless Steel
Body Material	:	316 Stainless Steel
Process Connection	:	½" BSP
Electrical Connection	:	20 mm entry for cable gland
Electronics Housing Protection	:	IP65
Overpressure limit	:	200% of maximum process static pressure
Mounting	:	Pipe stand or direct process connection as appropriate to application
Output	:	4-20mA into 250Ω load
Supply	:	24 V DC nominal (loop powered)
Calibration Adjustments	:	Independent Zero span
Element Temperature Limitation	:	100°C
Electronics	:	70°C
Humidity Limits	:	1-100% relative humidity
Accuracy	:	0.5% of span or better
Repeatability	:	0.1% of span
Dead Band	:	<0.1% of span
Ambient temperature effect	:	<0.5% of maximum span/10°C change

41. LEVEL GAUGE

General

a) Gauge/Sight Glasses shall be installed when a local indication of liquid level is required in an elevated vessel.
b) Where transparent liquids are to be measured, level gauges with magnetic followers will be used.
c) Where the level of liquids with non-varying SG needs to be indicated, in open vessels, pressure gauges, calibrated in level units (e.g.:% or meters), may be used.
d) Local indicators may be pneumatic or digital, depending on the type of level transmitter used.

Design

a) The mechanical construction of the gauge shall be capable of withstanding the temperatures, pressures, and media types for the application.
b) The gauges shall be supplied complete with isolation ball valves and drain/vent valves top and bottom.
c) Illumination shall be provided for gauge glasses to enable readings to be made in difficult lighting conditions.

42. HYDROSTATIC TYPE LEVEL TRANSMITTER

General

a) Transmitter shall be non-indicating, electronic type based on piezo-restive principle. The transmitter shall be a two wire, loop powered unit.

Specifications

Element Type	:	Diaphragm
Wetted Parts	:	316 Stainless Steel
Body Material	:	316 Stainless Steel
Process Connection	:	½" BSP
Electrical Connection	:	20 mm entry for cable gland
Electronics Housing Protection	:	IP68
Overpressure limit pressure	:	200% of maximum process static
Mounting	:	Mounting stands to be supplied
Output	:	4-20mA into 250Ω load
Supply	:	24 V DC nominal (loop powered)
Calibration Adjustments	:	Fixed range
Element Temperature Limitation	:	100°C
Electronics	:	70°C
Humidity Limits	:	1-100% relative humidity
Accuracy	:	0.5% of range or better
Repeatability	:	0.1% of range
Dead Band	:	<0.1% of range
Ambient temperature effect change	:	<0.5% of maximum range/10°C

43. PH METERS

General

a) Transmitter shall be of the electronic 2 wire type, suitable for field mounting and incorporating a local display. The electrode assembly shall be incorporated into a holder with options of either the immersion type or the flow through type.

Transmitter

Enclosure Protection	:	IP65 or equivalent
Electrical Connections	:	20mm cable entry for cable gland
Power Supply	:	24 V DC nominal
Output	:	4-20 mA into 250Ω load galvanically isolated
Temperature compensation	:	Automatic
Indication	:	L.C.D. preferred
Range	:	2-14 pH adjustable
Max Ambient Temperature	:	55°C

Electrodes

a) Reference electrode shall be of rugged and sealed construction, moulded in glass coupled polypropylene. Electrical connection shall be made directly onto the outer end of the element.
b) Measuring electrode shall be of toughened all-purpose glass type, adequately protected and giving accurate pH reading with long electrode life.
c) PT100 temperature measuring devices shall be included within the electrode assembly housing.
d) Electrodes shall be capable at operating in fluid temperatures of up to 80°C.

Performance

Accuracy	:	0.5% of span or better
Linearity	:	0.1%

44. OXYGEN ANALYSERS

General

a) The measurement of dissolved oxygen in water for general - purpose applications shall be by ampherometric cells, covered by a membrane.
b) The measurement of dissolved oxygen in water in harsh environments, where severe coating of the cell is experienced, shall be made by a pair of exposed electrodes which are mechanically cleaned.
c) Submersible cells are preferred. If the application requires a sample to be withdrawn, then the sample line shall be kept short, and shall be of metal, preferably stainless steel.
d) The cell shall be installed where sufficient flow exists.
e) The membrane thickness shall be chosen to suit both the response time required and the concentration of dissolved oxygen expected.

Design

a) Temperature compensation shall be standard.
b) Calibration shall be possible in the saturated vapour space above the water surface. Calibration tables showing correction factors for ambient temperature and barometric pressure shall be supplied. In addition to the above, calibration shall be possible, making use of calibration media.
c) The ampherometric cell and its support structure shall be shaped and aligned to reduce the collection of foreign matter at the cell.
d) The membrane shall be a secure fit. Field servicing shall be easy and performed with minimal or no tools required.

e) Scales shall be available as % saturation, ppm or mg/1. These scales, as well as the ranges, shall be selectable. The output shall be 4 to 20mA.

Performance

Accuracy	:	± 1%
Resolution	:	± 0.1%

45. TURBIDITY ANALYSERS

General

a) Turbidity in water shall be determined by nephelometry, i.e. the scatter of incident light by particles in the water.

Design

The Turbidity Analyser shall be supplied with standard BSP connections for sample ingress, egress and drain, suitably sized and placed to reduce the formation of bubbles. The complete analyser shall be accommodated in a single housing.
Signal output of 4 to 20mA shall represent a turbidity of 0 to 9999 NTUs, or any standard range up to 9999 NTU. This range shall be determined by the application, e.g.: clean water or dirty water.
The calibration media shall be supplied by the vendor of the analyser. The calibration media shall be formazin, accurately diluted to the required strength. Note that NTU = FTU, or Nephelometric Turbidity Units = Formazin Turbidity Units. Glass standards, as supplied by the vendor, are permissible.

Specifications

Accuracy	:	± 2% (0-50 NTU)
± 5% (0-2000 NTU)		
± 10 %(0-9999 NTU)		
Resolution	:	± 1%
Repeatability	:	± 1%

46. DEW POINT ANALYSERS

General

a) The principle of operation shall be based on a capacitive sensor in an oscillator circuit. A change in the water content of the sample changes the capacitance in the tuned circuit, resulting in a change of display, calibrated in water content units.
b) The analyser shall be capable of accurate measurement of trace amounts of water in air or other gas/vapour atmospheres. The range of water concentration to be measured is in the range of -80°C to +20°C Dew point, i.e.: trace amounts of water in the ppmv range.
a) The analyser shall consist of a sensor that may be directly installed into the process medium, and a remote converter that is installed in a protected environment.
c) The microprocessor based converter shall include for a digital display, showing the necessary parameters for programming, alarm status, and the value of the water concentration being measured, in selectable units.
d) Sensors that do not require extensive re-configuration for characteristic curves will be favoured.
e) The sensor shall be able to recover from saturation rapidly and shall be corrosion resistant. An option for attaching filters shall be available.

Specifications

Output	:	Isolated 4 to 20 mA, representing 80°C to +20°C

Power Supply : 24v DC or 220v AC
Display : Digital 3½ digits
Transmitter accuracy : ± 1% FSD

Sensor

Measuring range : -80°C to +20°C
Accuracy : ± 2°C Dew Point
Repeatability : ± 2°C Dew Point
Operating temperature : - 20°C to + 40°C (Ambient temperature)

47. SWITCHES

General

a) Switches shall be provided with an enclosure of a type suitable for the individual environmental conditions (Minimum IP65).
b) Actuating switches shall be snap action micro-switches. Contacts shall have a minimum rating of 3 Amps inductive breaking at 220 VAC.
c) All switches shall have two parallel contacts normally open/closed and the on-off differential of switches shall be adjustable.
d) Specific applications may demand that methods other than those listed below shall be used and these shall be issued for review to the Engineer for approval.

48. PRESSURE SWITCHES

Pressure switches shall generally be of the diaphragm, piston-cylinder type.

Element Material : Stainless Steel/Teflon to suit the application
Process Connection : Bottom entry, stainless steel
Electrical Connection : M20 gland entry
Max Process Pressure : To suit application
Max Process Temperature : 100°C
Max Ambient Temperature : 60°C
Switch Function : Single set point, SPDT
Switch Rating : 6A-22A, 30VDC to 250VAC
Adjustable Range : From 15% to 100%
Dead band : From 0.5% to 15%
Accuracy : 1, 0% of FS

49. TEMPERATURE SWITCHES

Temperature switches shall be filled systems or bimetallic.
Filled systems may be direct mount or capillary mount.
Capillary mount shall be used where applications make access to the head difficult.

Element Material : Bronze or Stainless Steel to suit the application
Electrical Connection : M20 gland entry

Max process Temperature : 100°C
Switch Function : Single set point, SPDT
Switch Rating : 6A-22A, 30VDC to 250VAC
Adjustable Range : From 15% to 100%
Dead band : From 0.5% to 15%
Accuracy : 1, 0% of FS

50. FLOW SWITCHES (PADDLE TYPE)

Flow switches shall be of the paddle type and shall have a low pressure drop, paddle which is changeable to suit the flow rate.

Wetted pants	:	Stainless Steel
Electrical Connection	:	M20 gland entry
Max Process Pressure	:	Up to 130 Bar
Max process Temperature	:	100°C
Switch Function	:	Single set point, SPDT
Switch Rating	:	6A-22A, 30VDC to 250VAC
Material of Construction	:	Brass or stainless steel
Flow sensing direction	:	Forward and Reverse

51. FLOW SWITCHES – THERMAL TYPE

Flow switches shall be of the thermal dispersion type and shall have a switch point which is changeable to suit the flow rate.

Wetted pants	;	Stainless Steel
Electrical Connection	:	Integral cable
Set point range	:	0.15 to 3.0 m/s
Max process Temperature	:	85°C
Response time	:	Maximum 10 seconds
Power requirement	:	9 to 24VDC
Ingress Protection	:	IP 65
Switch Type	:	1 * NO, PNP and 1 * NC NPN
Local Indication	:	LED’s showing visual switch indication
Empty pipe protection	:	Incorporated into switch design

52. LEVEL SWITCHES – CAPACITANCE ROD PROBE TYPE

a) Capacitance probes may be used as level switches.
b) The probe is one plate of a capacitor, so capacitance probes shall be used in media of varying moisture content.
c) Where non-conductive vessels are used, a counter-electrode shall be supplied and installed into the tank.
d) Probes shall be of a material that is compatible with the process media. Coatings, such as Teflon, shall be used to protect the rods in most applications.
e) Fully insulated probes shall be used for aggressive liquids and highly adhesive media
f) Partially insulated probes shall be used for powders and granular bulk materials

Specifications:

Wetted pants	;	PTFE insulated stainless steel rod
Electrical Connection	:	M20 gland
Max process Temperature	:	-50 to 200°C
Response time	:	Maximum 10 seconds
Power requirement	:	9 to 24VDC
Ingress Protection	:	IP 65
Switch Type	:	1 * NO, PNP and 1 * NC NPN
Local Indication	:	LED’s showing visual switch indication
Empty pipe protection	:	Incorporated into switch design

53. LEVEL SWITCH – CONDUCTIVITY TYPE

a) Conductivity probes may be used as level switches.
b) The conductivity of the medium with respect to a reference probe, or the wall of a conducting vessel is used to determine the switch point.

Specifications:

Type	:	Compact multipoint detection
Sensor Length	:	0.1m to 4 m
Wetted pants	;	insulated stainless steel rod
Electrical Connection	:	M20 gland
Max process Temperature	:	-40 to 100°C
Power requirement	:	9 to 24VDC
Ingress Protection	:	IP 65
Switch Type	:	1 * NO, PNP and 1 * NC NPN or Relay
Local Indication	:	LED’s showing visual switch indication

54. LEVEL SWITCH – NUCLEONIC TYPE

a) No work shall proceed until the Contractor and the End User (Owner) have satisfied all the regulations governing the handling and transport of nuclear sources. All installations shall be clearly marked with the approved Radiation Warning signs.
b) Transmitter electronics shall be either local or suitable for mounting in a cabinet or panel, depending on the application.
c) The source holder shall be fitted with a lockable shutter to permit sage maintenance when required.
d) Mounting brackets shall be secure and corrosion resistant.
e) The detector shall be suitable for mounting on vessels that are cathodically protected.
f) Only the manufacturer’s approved parts shall be used for the installation.

Specifications:

Type	:	Radiometric, non-contact
Power requirements	:	19 to 253VAC
Ambient temperature	:	-40 to 70°C
Process temperature	:	Any
Main wetted parts	:	None, non-contact
Output	:	Relay DPDT

55. LEVEL SWITCH – FLOAT TYPE

Specifications:

Measuring principle	:	Float switch/buoyancy
Ambient temperature	:	-20 °C to 85 °C
Process temperature	:	-20 °C to 85 °C
Minimum density of medium	:	0.8 g/cm3
Main wetted parts	:	PUR/PVC to suit medium
Sensor cable length	:	20m maximum
Ingress Protection	:	IP 65 minimum
Switch Type	:	1 * NO, PNP and 1 * NC NPN or Relay
Local Indication	:	LED’s showing visual switch indication

56. VIBRATION SWITCH (LEVEL)

a) Vibration switches shall be used, when required, for monitoring of electrical motor and pump vibration.

b) Single-channel or multi-channel configurations are acceptable, to suit the application. The control unit shall be microprocessor based.
c) Two configurable outputs per channel for pre-alarm and alarm points shall be available.
d) Vibrations in the range of 0 to 20 mm/s shall be detected.

Specifications:

Type	:	Compact, turning fork type
Measuring principle	:	Frequency damping
Ambient temperature	:	-20 °C to 85 °C
Process temperature	:	-20 °C to 85 °C
Minimum density of medium	:	0.8 g/cm3
Main wetted parts	:	PUR/PVC to suit medium
Sensor cable length	:	20m maximum
Ingress Protection	:	IP 65 minimum
Switch Type	:	1 * NO, PNP and 1 * NC NPN or Relay
Local Indication	:	LED’s showing visual switch indication

57. PROXIMITY SWITCH

a) Proximity switches shall be encapsulated and shall operate on a magnetic field principle.
b) The switch shall have a LED indicator and have a detection range of 10 - 15 mm.
c) Proximity switches shall have a mechanical adjustment on the mounting bracket of at least 35 mm.

Specifications:

Type	:	Inductive sensor
Connection	:	Integral cable
Sensing range	:	10-15mm
Output	:	DC, PNP
Operating voltage	:	10 to 60VDC
Reverse polarity protection	:	Yes
Overload protection	:	Yes
IP Rating	:	IP 67/IP 69K
Mounting	:	Non-flush mountable
Housing	:	Stainless steel

58. WEIGHTOMETERS

General

a) Load cells, using the strain-gauge principle, shall be used, when specified, for accurate measurement of large masses.
b) The mechanical/structural design shall be designed so as to keep horizontal forces to a minimum.
c) Load cells shall be connected in parallel and correctly shimmed to ensure equal load distribution. Three cell configurations are preferred where reasonable.
d) Protection against electrical noise and lightening is essential. Particular care shall be exercised regarding the earthing requirements.
e) Load cells shall be hermetically sealed and the terminal boxes shall offer protection to IP65.
f) Temperature compensation shall be incorporated
g) Ranges shall be 0 - 10kg, up to 0 - 200t

Maximum usable load	:	150% of range
Ultimate load	:	500% of range
Accuracy	:	$<$ 0.1%
Repeatability	:	$<$ 0.02%

59. ELECTRIC ACTUATORS

General

The actuators shall be suitable for use on a nominal 220 Volt AC, 50/60 Hz, single phase power supply and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self-contained, sealed enclosure.

In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts shall be carried out without the removal of any actuator covers over an infra-red interface. Sufficient commissioning tools shall be provided with the actuators and must meet the enclosure protection and certification levels of the actuators. Commissioning tools shall not form an integral part of the

actuator and must be removable for secure storage/authorised release. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning tool.

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

Actuators shall be supplied with an internal battery pack to allow fail-safe positions in the case of power loss.

Actuator sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. For linear operating valves, the operating speed shall be such as to give valve closing and opening at approximately 25-30 cm per minute unless otherwise stated in the data sheet.

Environmental

Actuators shall be suitable for outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from -33°C to 70°C, up to 100% relative humidity.
Actuators for hazardous area applications shall meet the area classification, gas group and surface temperature requirements specified in data sheet.

Enclosure

Actuators shall be 0-ring sealed, watertight to IP68. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site for cabling, the terminal compartment having the same ingress protection rating as the actuator with the terminal cover removed.
Enclosure must allow for temporary site storage without the need for electrical supply connection.

All external fasteners shall be zinc plated stainless steel. The use of unplated stainless steel or steel fasteners is not permitted.

Motor
The motor shall form an integral part of the actuator, designed specifically for valve actuator applications. It shall be of a low inertia high torque design, class F insulated with a class B temperature rise giving a time rating of 15 minutes at 40°C at an average load of at least 33% of maximum valve torque. Temperature shall be limited by thermostats embedded in the motor end windings and integrated into its control circuit.

Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case.

Motor Protection
Protection shall be provided for the motor as follows:
Stall - the motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
Over temperature – the in-built thermostat will cause tripping of the motor. Auto-reset on cooling will occur at the device
Single phasing - lost phase protection
Direction – phase rotation correction

Gearing
The actuator gearing and casing shall be designed for installation in the intended installation environment. The design should be such as to permit the opening of the gear case for inspection or disassembled without

releasing the stem thrust or taking the valve out of service. For 90° operating type of valves drive gearing shall be self-locking to prevent the valve back driving the actuator.

Hand Operation
A hand wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand wheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the data sheet. For linear valve types the actuator hand wheel drive must be mechanically independent of the motor drive and should be such as to permit valve operation in a reasonable time with a manual force not exceeding 400N through stroke and 800N for seating/unseating of the valve.

Drive Bushing
The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base should be of the sealed for life type.

Torque and Turn Limits

Torque and turns limitation to be adjustable as follows:
Position setting range – multi-turn: 2.5 to 100,000 turns, with resolution to 15 deg. of actuator output
Position setting range – direct drive part turn actuators: 90° +/-10°, with resolution to 0.1 deg. of actuator output
Torque setting: 40% to 100% rated torque
Measurement of torque shall be from direct measurement of force at the output of the actuator. Methods of determining torque-using data derived from the motor such as motor speed, current, flux etc. are not acceptable.

A means for automatic “torque switch bypass” to inhibit torque off during valve unseating and “latching” to prevent torque switch hammer under maintained or repeated control signals shall be provided.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

Remote position and indication

Two potential free contacts shall be provided which can be selected to indicate open and closed position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during manual hand wheel operation when all external power to the actuator is isolated.

The contacts shall be rated at 5A, 250V AC, 30V DC.

Contacts shall also be provided for the following:
Valve opening, valve closing
Motor tripped
Remote selected
Actuator in manual

Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required. The transmitter will auto range to the set limits.

Local position indicator

The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully closed in 1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With main power on the display shall be backlit to enhance contrast at low light levels and shall be legible from a distance of at least 6 feet (2m).

Red, green, and yellow lights corresponding to open, closed, and intermediate valve positions shall be included on the actuator display when power is switched on. The digital display shall be maintained and updated during hand wheel operation when all power to the actuator is isolated.

In addition, the actuator display shall include a separate text display element with a minimum of 32 characters to display operational, alarm and configuration status. Provision shall be made to upload a different language without removal of any covers or using specialized tools not provided as standard with the actuator.
Provision shall be made to orientate the actuator display through increments of 90deg.

Local torque indication

The digital display shall be capable of indicating real time torque and valve position simultaneously, both being displayed in 1% increments of valve position and actuator rated torque. In addition torque shall also be displayed in horizontal bar graph form.

Integral starter and transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation.

The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tappings and be adequately rated to provide power for the following functions:

- Energization of the contactor coils
- 24V DC output for remote controls
- Supply for all the internal electrical circuits

Local controls

The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

Provision shall be made to orientate the local controls through increments of 90deg.

Control facilities

The necessary control, wiring and terminals shall be provided in the actuator for open and close external interlocks to inhibit local and remote valve opening and/or closing control.

It shall be possible to configure the interlocks to be active in remote control only.

Remote controls fed from an internal 24V DC supply and/or from an external supply between 20V and 120V AC or 20V and 60 V DC, to be suitable for any one or more of the following methods of control:
Open, Close and Stop control
Open and Close maintained or “push to run” (inching) control
Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact
Two-wire control, energise to close (or open), de-energise to open (or close)
It shall be possible to reverse valve travel without the necessity of stopping the actuator. The motor starter shall be protected from excessive current surges during rapid travel reversal.
The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2kV.

Monitoring facilities

Facilities shall be provided for monitoring actuator operation and availability as follows:
Motor thermostat tripped
Actuator internal fault
Actuator text display indication of the following status/alarms:
Closed Limit, open limit, moving open, moving closed, stopped
Torque trip closing, torque trip opening, stalled
ESD active, interlock active
Thermostat trip, phase lost, 24V supply lost, Local control failure
Configuration error, Position sensor failure, Torque sensor failure
Battery low, power losses inhibit

Wiring and terminals

Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.

The terminals shall be embedded in a terminal block of high tracking resistance compound.
The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal and shall be provided with a minimum of 2 threaded cable entries with provision for a maximum of 4.

All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
Serial number
External voltage values
Wiring diagram number
Terminal layout
The code card shall be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

60. INSPECTIONS AND TESTS BY THE ENGINEER

Inspections:

The inspection of the instrumentation, by the Engineer, shall include the following:

- Correct choice of field instrumentation (application examples to be presented)
- Correct sizing of field instrumentation (calculations to be presented)
- Correct selection of mechanical interfaces (drawings to be presented)
- Review of the Contractor’s Quality Control Documentation (check-lists to be presented)

Tests:

The testing of the instrumentation system, by the Engineer, shall include the following:

- Verification of calibration
- Verification of measured values
- Correct operation of trip signals
-

61. DOCUMENTATION

This following documentation shall be provided by the Contractor at the various project phases listed below, in the formats provided:

With Tender
- Instrumentation manufacturer’s datasheet

During Construction
- Instrumentation sizing calculations
- Instrumentation hook-up diagrams
- Instrumentation loop diagrams
- Instrumentation termination diagrams
- PLC panel schematic/wiring drawings
- Instrumentation trip signal listing

- Instrumentation alarm signal listing

As Built

- Instrumentation hook-up diagrams
- Instrumentation loop diagrams
- Instrumentation termination diagrams
- PLC panel schematic/wiring drawings

62. TYPICAL INSTRUMENTATION DATASHEET

			MASS FLOWMETER (CORIOLIS FLOWMETER)		SPEC. NUMBER. 200-FT-300	REV.
			NO / BY / DATE / REV		SHEET 1 OF 1	DATE
					BY / CHECK	APPR.
					P.O. P0344	
Project	Training				REQ. REQ006	
GENERAL	1	Element Tag No. (Remote)	200-FT-300			<-
	2	Service	Refined Oil to Heat Transfer			<-
	3	P&ID				<-
	4	Line Number				<-
	5	Line Size & Schedule				<-
	6	Line Material				<-
	7	Area Classification				<-
ELEMENT	8	Tube Size / Face-Face				<-
	9	End Conn. / Press.Class				<-
	10	Conn. Matr'l / Tube Matr'l				<-
	11	Power Supply				<-
	12	Case Matr'l / Rating				<-
TX	15	Tag Number				<-
	16	Output Signal				<-
	17	Power Supply				<-
	18	Smart / Communication				<-
	19	Mounting				<-
	20	Case Matr'l / Rating				<-
	21	Display				<-
	22	Signal Cable Length				<-
FLUID DATA	25	Fluid Code				<-
	26	Fluid Description				<-
	27	Max / Oper. / Min Flow				<-
	28	Spec. Gravity @ Oper.Temp.				<-
	29	Max. Viscosity @ Oper.Temp.				<-
	30	Max. Press. / Oper. Press.				<-
	31	Max. Temp. / Oper. Temp.				<-
	32	Density @ Operating Temp.				<-
	33	Std.Density / Mol. Weight				<-
	34	Max Velocity / Min Velocity				<-
	35	Max. Allow. Press. Drop				<-
	41	Manufacturer	ROSEMOUNT			<-
	42	Diff. Press @ Operating Flow				<-

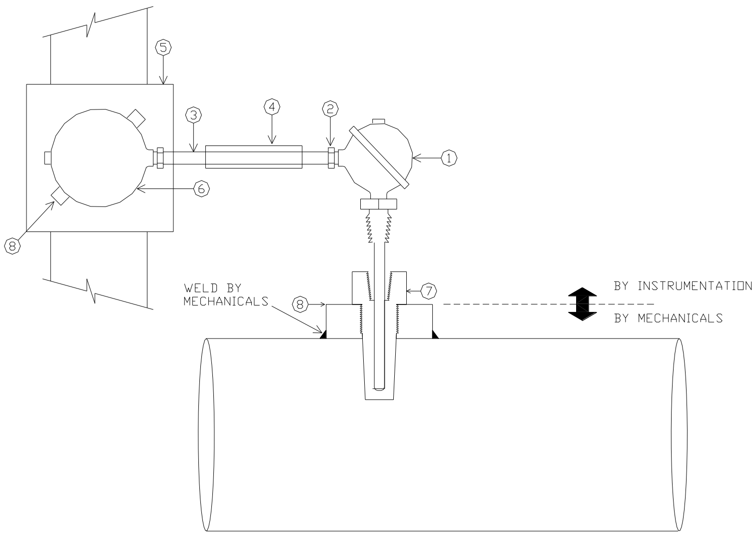
NOTES:

63. TYPICAL INSTRUMENTATION HOOKUP DIAGRAMS

ss)

THERMOCOUPLE/RTD WITH

Client Name	**INTERGRAL TRANSMITTER**		
Project Name	**Dwg. No.**	**RTD**	**Sheet** 1
Instrument Hook-up Diagram	**Rev Date**		**Rev**



QUANTITY

ITEM NO	QUANTITY	DESCRIPTION
1	1	TEMPERATURE ELEMENT
2	3	CABLE GLAND (No.0 COMPRESSION)
3	A/R	INSTRUMENT SIGNAL CABLE
4	A/R	25 X 25 ANGLE IRON CABLE SUPPORT
5	1	3CR12 MOUNTING PLATE
6	1	2 WAY PRATLEY BOX
7	1	THERMOWELL

TAG LIST

TAG NUMBER	SERVICE / DESCRIPTION	MANUFACTURER	MODEL
	TE,TT,TY,TV		TEMPERATURE TX
	TE		

F253 - STANDARD SPECIFICATION FOR TELEMETRY SYSTEMS

1. GENERAL

The following describes the minimum requirements for radio telemetry systems when used in the context of automation, control and data acquisition applications.

The specification describes minimum requirements for the Remote Terminating Units (RTU's), communications equipment, communications protocols and all peripheral components associated with the system.

2. REFERENCE SPECIFICATIONS

All equipment shall comply with the following SANS, SABS, IEC, ISA standards, regulations and the latest revisions there-of:

tt) Standard	uu) Description
IEC 60068	Environmental Testing
IEC 60096	Radio-frequency cables
SANS/IEC 60099	Surge arresters
IEC 60169	Radio-frequency connectors
IEC 60870	Telecontrol equipment and systems
SANS/IEC 61000	Electromagnetic compatibility (EMC)
IEC 62443	Industrial communication networks - Network and system security (DRAFT)
IEC 62351	Security of TC 57 series of protocols
ICASA	The Electronic Communications Act

3. DETAILED SPECIFICATION

1.1 Remote Terminating Units (RTU)

General

Remote Terminating Units shall provide the physical interface between the process being monitored or controlled and the automation system via a communications medium that is based on either an electrical data connection or a radio data connection as described in the Project Specification ***.

The RTU shall be a modular industry standard unit from a reputable internationally recognized supplier with minimum features as described below. Custom or purpose built units will not be acceptable.

The suppliers shall be permanently represented in the RSA and shall guarantee the availability of local field service facilities and unit replacement ex-stock from the local depot.

Equipment Specification

The RTU hardware shall consist of the following modular units:

- A Power Supply Unit (PSU)
- A Central Processing Unit (CPU)
- Input / Output Modules (IO)
- Communications Processors (CP)

All RTU hardware shall be field-proven under similar conditions and shall be suitably protected against excessive temperature, electrical and electromagnetic interference, input and output overvoltage or short-circuit, as well as any further site environmental constraints.

All components shall be either DIN rail mounted or common back plane mountable in order to form a neat and compact installation.

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 wiring.

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.

PSU:
The PSU shall be a UL approved regulated unit that can be fed from either 230VAC 50Hz or 24VDC supply as described in the Project Specification ***. The output voltage and power of the unit shall be selected to suit the RTU installation and all associated peripherals. I.e. To power the CPU, IO Modules, CP modules and all Input and Output circuits plus 25% spare capacity.

CPU:
The CPU shall be a dedicated or programmable unit as selected in the Project Specification ***.
If a Programmable RTU is offered it 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 shall be supplied with 20% excess program memory and I/O capacity for initial operation of all specified process components. However, the system shall allow for future expansion of up to 50% additional memory and I/O capacity.

IO Modules:

All Input and Output modules shall have LED status indication clearly visible from the front of the modules.

Input cards shall support 4, 8 or 16 inputs per module however a maximum grouping of 8 inputs with a single common shall be allowed per module.

Output modules shall be of the transistor or opto-electric switched solid state relay (SSR) type. Output cards shall support 4, 8 or 16 outputs per module.

The output 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. 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.

For both the input and the output modules the LED’s shall give a true load - side indication to and from the field devices.

Analog input modules shall be of the multiple input range type. This may be either by means of plug-in type measuring range adapter 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 Analog inputs with relatively slow changing values is required to be monitored, Analog multiplexer modules may be used. The multiplexer shall be compatible with the Analog input module and shall therefore be supplied by the same manufacturer. The input resolution of the multiplexer shall be a minimum of 12 bits.

Analog Input cards with 2, 4 or 8 channels shall be supported.

Analog output modules may be dedicated output range type. The output resolution shall be a minimum of 12 bits. The outputs shall be electrically isolated from the logic circuitry and shall be electrically isolated from each other. Output modules with “Communication Active” indicators are preferred.

Analog Output cards with 2, 4 or 8 channels shall be supported.

Galvanic isolation in the form of opto-isolators shall be provided for all inputs and outputs and the driving logic of the modules.

All outputs shall revert to the off state when the RTU CPU fails or is switched off or is re-started (i.e. Run mode switched from stop to run)
The onus is on the Tenderer to determine the precise I/O requirements and provide the necessary I/O’s with spare allowance as per the requirements set out in the Project Specification ***.

All Inputs and outputs, digital and analog, shall be clearly labeled with the relevant plant equipment Tag number. Labels shall be printed in black on white and either inserted in the IO Card connector block or printed on adhesive paper which shall then be adhered to the IO Card or connector block.

The IO lists provided in the Project Specification*** are regarded as the minimum requirements and the exact IO’s shall be derived during the contract technical clarification.

1.2 Data Communications:

The RTU shall be able to communicate with a SCADA system and/ or with other RTU’s via an industry standard data communications connection and protocol as specified in the Project Specification ***.

The communications interface shall be integral to the RTU CPU or consist of a separate modular card.

The physical layer interface supported by the communications interface shall be RS232, RS485 or Ethernet as selected in the Project Specification ***. The physical communications media that shall be supported shall be either electrical, optical or electromagnetic (radio).

A robust and secure communications protocol that adheres to a deterministic message passing methodology shall be used, such as Modbus RTU, Distributed Network Protocol (DNP3), IEC60870-5-101, MPT1327or Transport Control Protocol / Internet Protocol (TCP/IP) as selected in the Project Specification ***.
Data communications failure shall not affect the operation of the RTU in any way and messages that would have been sent on the healthy network shall be buffered and re-sent when the data connectivity is restored.

All RTU to RTU and RTU to SCADA communications message blocks shall be clearly documented. Sufficient spare capacity shall be assigned for future message extensions. All message items (status bits and measured value words) shall be uniquely addressed.

1.3 Equipment installation

The RTU panel manufacturer shall adhere strictly to the recommended mounting, earthing and electromagnetic shielding requirements of the RTU supplier.

The panel shall conform to the Standard Specification For Electronic Installations and the manufacturer shall confirm to the Engineer that the RTU and its components 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 RTU shall be taken into consideration when designing the compartment housing the apparatus.

If forced ventilation and / or panel heaters are required to provide the climate necessary for the RTU apparatus, then this shall be included in the panel design, together with 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 RTU in order to alert the operator via the alarm panel if the “climate” drifts outside the preset values.

The RTU shall be installed in a wall mountable panel with a lockable door such that the equipment is secure and undisturbed. The door shall be monitored by an intrusion detection switch which status shall be communicated to the control system together with other condition monitoring signals described in this specification.

1.4 Communications systems

General

The RTU shall be connected to the automation and control system via a suitable data communications consisting of either electrical, optical or electromagnetic propagation (radio) medium as specified in the Project Specifications ***.

For mission critical installations dual redundant communications medium shall be provided when called for in the Project Specification ***.

For the each of the medium, the following minimum requirements shall apply.

Electrical Line Drivers (Modems)

Where the RTU is connected to a control system, such as a SCADA computer via electrical communications cable, the RTU or its communications module shall provide the physical link connection and include line drivers to achieve the communications distance.

The physical link shall be an RS232 or RS485 based serial communication provided on a SubD 9 pin port with frequency shift keying (FSK) modulation onto the physical medium via a set of screw terminals and shall support message protocols as described in section XXX of this specification.

Where dedicated transmission lines are used the physical length limitations of the selected technology shall be observed and where greater distances are required appropriate repeaters shall be installed.

Where a telecommunications service provider line is used the line driver (modem) shall include Dial Tone Modulation Frequency (DTMF) keying and support the Hayes commands set with which a connection to a specific location can be established.

The transmission lines and modem equipment shall be protected by class 3 data communications line surge arrestors appropriate for the transmission medium and protocol selected.

The transmission line physical properties shall be as specified in the Project Specification ***

Fiber Optic Transceivers (Modems)

Where the RTU is connected to a control system, such as a SCADA computer via optical fibre cable, the RTU or its communications module shall provide the physical link connection and appropriate line drivers shall be used to achieve the communications distance.

The physical link shall be an RS232 or RS485 based serial communication provided on a Sub D 9 pin port with optical pulse width modulation onto the physical medium via a pair of ST connectors and shall support message protocols as described in section XXX of this specification.

The optical fibre line physical properties shall be as specified in the Project Specification ***

1.5 Radio Transceivers (Modems)

General

Only radio carrier equipment which is approved by the Independent Communications Authority of South Africa (ICASA) for use in the Republic of South Africa in terms of Radio Act, Act 3 of 1952 as amended, will be accepted. The contractor shall, on request, provide the Engineer with a copy of the relevant certificate of approval (Type approval certificate) for the equipment offered.

Radio transceivers shall preferably be fully synthesized and programmed only for those frequencies granted by ICASA for use in the project area.

The type of radio communications selected shall be either Ultra High Frequency (UHF) Radio, Global System for Mobile (GSM), Digital Trunked Radio or Spread Spectrum Radio as specified in the Project Specification ***.

The system selection shall be made on the following basis:

vv)	ww)	**xx) Criteria**			
yy)	zz)	**aaa) N° of Outstations**	**bbb) Amount of Data**	**ccc) Data Rate**	**ddd) Criticality**
eee) Selection	**fff) GSM**	ggg) Low	hhh) Low	iii) Medium	jjj) Non-critical
	kkk) UHF	lll) Medium	mmm) Medium	nnn) Medium	ooo) Medium
	ppp) Trunked	qqq) High	rrr) Low	sss) Low	ttt) High
	uuu) Spread Spectrum	vvv) Low	www) High	xxx) High	yyy) High

VHF/UHF Radio:

Radio communications modems utilizing the UHF band shall be used since the use of VHF is no longer permitted. The radios shall be standard supply from reputable manufacturers and meet the requirements for physical interfacing to the RTU described above and shall be capable of the protocols described in Section 3.3 below.

Each radio, whether intended for base station, outstation or repeater use, shall incorporate both a transmitter and receiver.
The transmitter shall comply to the following minimum requirements:

A multi-position switch or push buttons shall be provided on each transceiver (or transmitter and receiver if they are separate) which will allow the operator to switch the station to the preferred channel. In the case of repeater stations and fixed stations, this switch shall be an internal software switch.

The spurious and harmonic radiation shall, at its maximum, be of a level not greater than 1 microwatt in case of repeater stations and fixed stations. The transmitters offered shall be capable of operating continuously without dropping below the rated power.

Frequency or phase modulation, type F3, shall be used in all transmitters. 100 % Modulation shall cause a minimum 2,5 kHz deviation.

Frequency stability of all transmitters shall be better than 2,5 parts per million from –10°C to +55°C.

The audio frequency response will be within +1 dB and -3 dB relative to a pre-emphasis characteristic of 6 dB per octave over the frequency range 300 - 3 000 Hz.

For data communications the audio frequency response shall be flat.

The audio frequency distortion shall be less than 5 % at an audio output of 300 mW rms. when the RF transmission is modulated by a 1 000 Hz audio tone to a modulation depth sufficient to produce 60% frequency deviation.

3Channel spacing, transmitter output power, antenna gains and front- to-back ratios, etc, shall conform to the ICASA norms and licenses. Enhancement of the minimum standards shall be such that communication reliability shall be 99% for voice communication and 99,99% for data (e.g. telemetry) communication paths.

RF power output measured at the antenna shall under no circumstances exceed that granted by the Department of Communications, nor shall it be less than 30% of such values. Antenna SWR shall be 1,1:1.

The use of down-powered equipment to meet statutory regulations shall be avoided. If, e.g., relatively high powered commercial transceivers have to be used in telemetry applications for economic reasons, then the Contractor shall be required to prove to the Engineer that no degradation shall occur. The Contractor may, at the Engineer's discretion, be required to have his equipment's performance verified by an independent body, and/or to obtain ICASA sanction for use of the apparatus in the particular application. Costs of such tests will be for the account of the Client if such tests prove the equipment to be to specification. Otherwise the tests and rectification measures will be for the account of the Contractor. This shall include diverse cost items for any involvement required by the Engineer or Client.

Receivers shall comply with the following:

The usable sensitivity shall be such that a receiver input of 0,4 microvolt or less shall be required to produce 20 dB quieting as measured by the EIA SINAD method (0,3 microvolt for 12 dB SINAD).

The selectivity of the receiver shall be better than -90 dB for VHF and -85 dB for UHF at the adjacent channel positions (12,5 kHz) as measured by EIA standard RS 204, Section 7.

The spurious and image frequency rejection shall be such that the residuals are not greater than 85 dB below the centre frequency signal, which produces 20 dB noise quieting. The inter-modulation attenuation shall be better than 85 dB measured by the EIA standard, paragraph 9.2.

On all fixed receivers a carrier-operated squelch, adjustable in the onset of its "opening", shall be provided. An input signal of a maximum of 0,25 microvolts shall be capable of causing the squelch to "open". The squelch shall not "open" on short period noise bursts. The squelch shall be set internally. No outside adjustments shall be provided.

The audio frequency response shall be within +1 and -3 dB relative to the de-emphasis characteristic of 6 dB per octave over the frequency range 300 - 3 000 Hz.

The audio level stability shall be within 3 dB for receiver RF input level variation from 1 microvolt to 100 microvolts.

GSM Modems:

The GSM modem shall comply the following:

The modem shall operate in dual band GSM 900 and 1800 MHz.

The modem shall be compliant with ETSI GSM Phase 2+ standard.

The GSM engine shall be fully type tested and the supplier is required to submit the test reports along with the offer.

The modem shall be able to operate at:

- Class 4 (2 W @ 900 MHz)
- Class 1 (1 W @ 1800 MHz)

The following service shall be supported:

- Short Messaging Service (SMS) features.
- Point to point transmission as well as cell broadcast features.
- CSD Asynchronous non transparent up to 9.6 kbps.
- HSCSD (2+1) up to 28.8 kbps
- Serial binary and asynchronous data format for data transfer

The modem shall have command buffer of at least 40 characters.

The modem shall have auto-dial feature.

A SIM card hold holder shall be provide on the GSM mother board and shall be accessible only after removal of cover of the GSM modem.

It shall not be possible to insert / remove the SIM card without opening the modem enclosure. It is desirable to have further interlocking facility under the modem enclosure.

Separate ESD (Electro-static Discharge) protection for the SIM card shall be provided on the PCB. (The Opening and closing of IAMR with human hand may damage the SIM inside the modem due to ESD).

Tenderers shall state the specification of the SIM card to be used for the offered modem.

An SMA interface shall be provided on the GSM modem to which either a fixed, removable or wired dual band antenna of 3 dbi gain can be connected.

The antenna may be either directly mounted to the modem where it is installed in the telemetry enclosure or shall be provided with a suitable RF cable and external mounting plate for mounting on top of the enclosure or an outside mast as specified in the Project Specification ***..

The modem shall have sufficient memory to store resident software and data. The memory shall be scalable / upgradeable via the insertion of Miscro SD memory modules.

The modem shall have non-volatile memory, so that the registered parameters will not be affected by loss of power.

The non-volatile memory should have a minimum retention time of 10 years.

Inbuilt 32MB non-volatile Data memory (Expandable to 128MB). Data memory for storing telemetry data, tamper information, levels, flows etc.

The modem shall have a real time clock and calendar with a battery totally independent of the external power supply.

GSM time would be synchronized in both the RTU and the modem to take care of RTC variation errors.
The modem shall be supplied in a DIN rail mountable housing with minimum IP42 rating and be suitable for the installation in a telemetry enclosure to be installed in the environment as described in the Project Specification.

The modem shall have an LED for status indication in the front which should clearly be visible from a distance.

The LED shall indicate the operational status of the modem by colour and on/off or flashing states such as:

- absence of SIM card
- no service or insufficient signal strength.
- non-availability of power to the modem.
- healthiness of the modem
- data communication in progress..

The tender shall qualify any other arrangement as a substitute to the above.

Power supply to the modem shall be via an external 230VAC to 5-9VDC adapter suitably rated for the modem. The interface shall be either a DIN DC socket and plug arrangement or a set of screw terminals.

The modem shall have capability to send / to receive data in asynchronous mode, transparent and non-transparent up to 14,400 bits per second.

The modem shall have non-transparent data transmission at 1200 /2400 / 4800 / 9600 bps. The rate shall be selectable via configuration software.

The modem shall be supplied with configuration software that can be loaded on a laptop computer in order to configure the modem. The configuration shall be printed out in hard copy format and included in the installation Operations and Maintenance manual.

The following dialling features shall be included and configurable with the above software:

<u>Outbound dialling facility:</u>

The modem shall have outbound dialling facility to a particular GSM or PSTN number at specified time (Hourly/ daily / weekly / monthly etc) for the purpose of data reporting.

If the modem fails to establish connection to the modem placed at the central station at specified time then it shall retry the same continuously for number of times. The number of times the modem will try shall be configurable through the offered software.

<u>Event Based Dialling:</u>

The modem shall initiate a data call in the event of any tamper being logged by the RTU and shall be able to send the relevant data to the central control station.

The modem shall also send an SMS of minimum length of 150 characters which shall contain the RTU Number, Name of the outstation, area, mobile number, tamper description, date and time of tamper occurrence /restoration.

It shall be possible to select all or group of tampers for initiating SMS service.

When all the voltages are not available, the modem shall be able to detect power-off event and power-on event when supply is restored. Logging of power off event and power on event will be done on the next power up event. The power on and off event will be logged with date and time. A SMS shall be initiated by modem for such event.

<u>Inbound Dialing:</u>

It shall be possible to initiate a data call from the central control station to the GSM modem. The connection shall be established by the server to the device using AT commands and transparent communication mode shall be established. Whatever data is coming on the serial port of the modem shall be transferred to the RTU and response from the RTU shall be transferred to the base computer software.

The user shall have an option to collect the data directly from the RTU or data already available in memory of the modem.

A Facility to differentiate data inbound or outbound calls resulting in drop calls shal be provided.

<u>Data Transfer between the Modem and the base station:</u>

There shall be four different ways RTU data transfer shall take place between modem and Control System base station:

- Transparent mode with outbound dialling (The base station initiates reading of RTU data on user request or through scheduler.)
- Non-transparent mode with outbound dialling (The base station initiates reading of meter data available in the modem memory.)
- Non-transparent mode with inbound dialling (The modem shall initiate data transfer at a scheduled time configured in modem. The data stored in the modem is forwarded to the base station).
- Non-transparent mode with event based outbound dialling (The modem shall initiate data transfer on occurrence of an event registered by the RTU. The data stored in the modem is forwarded to the base station).

The contractor shall be responsible for signing the client up for a GSM contract with his preferred service provider and obtaining a valid SIM card for the GSM modem. The GSM contract shall be a monthly billed contract which will be paid by the client's account department.

Trunked Radio:
Digital Trunked Radio shall be utilized where Telemetry network congestion is anticipated and /or additional parallel radio service such as maintenance and operations staff voice communications are required.

The trunked radio shall employ Time Division Multiple Access (TDMA), two-slot technology digital radios conforming to the ETSI-TS102 standard.

The system shall support both fixed and mobile radio installations for both voice and data radio installations (or a mix of the two were required as specified in the Project Specification***).

A licensed RF spectrum of frequencies in the 403-470MHz range shall be utilized.
RF Output power in the licensed bands shall be between 1-25W for low power installations and 25-50W for high power installations. (Unlicensed installation with RF power output below 500mW may be permitted if the situation warrants it)

The radio shall be supplied via either a 230VAC supply or 12VDC supply and shall be either DIN rail mountable or 19" rack mountable.

The modem shall have an LED cluster for status indication in the front which is clearly visible from a distance. The LEDs shall display the following as a minimum.

- Power Supply Healthy
- Radio Healthy
- Data transfer (flashing

A backlit LCD display with rubber keys for function selection shall furthermore be provide on the face of the radio. It shall also be possible to select a radio with removable faceplate.

The LCD display shall provide the interface for all configurations parameters and function selection of the radio and the radio shall be accompanied by a clear instruction manual for accessing the parameters and configuration settings of the radio. A progressive menu structure shall be provided on the LCD for navigation of all settings.

It shall also be possible to program the radio with a software program that can be loaded onto a laptop for configuration of the radio. The radio connection shall include a MAP interface for this purpose.

It shall furthermore be possible to access and configure each radio (and repeater) in the trunked system via the data channel. The software shall be supplied with the radio and all settings and configuration shall be recorded and inserted in the Operations and Maintenance Manual. Full training in the use of the software shall be included.

For radios that support both voice and data, a separate audio system consisting of a loudspeaker in a panel mountable enclosure and a handheld microphone with "curly cord" and PTT shall be provided. Both units shall connect to the Radio via a DIN plug and socket arrangement.

The radio shall support a Frequency Stability +/- 0.5 ppm over the following temperature range (-30° C, +60° C, +25° C)

Modulation Limiting shall be +/- 2.5 kHz @ 12.5 kHz and+/- 5.0 kHz @ 25 kHz

FM Hum and Noise shall be no more than -40 dB @ 12.5 kHz and -45 dB @ 25 kHz

Conducted / Radiated Emission of -36 dBm < 1 GHz and -30 dBm > 1 GHz shall be guaranteed.

Adjacent Channel Power shall be no more than -60 dB @ 12.5 kHz and -70 dB @ 25 kHz

An Audio Response of +1, -3 dB shall be guaranteed and an Audio Distortion of less than 3%

A minimum of 9600kbs “over the air” data rate shall be possible over each data channel.

<u>Spread Spectrum Radio:</u>

Spread Spectrum Radio shall be utilized for high data throughput connections such as between telemetry base stations or between SCADA base stations and the client head office which warrant the use Wireless Ethernet connections.

Wireless Ethernet modems complying to the IEEE802.11 standard for Wireless Local Area networks shall be supplied.

The modems shall be certified by the Independent Communications Authority of South Africa (ICASA) and where networks with an output power of greater than 500mW are required these will be licensed by the ICASA. The contractor shall be responsible for applications and licensing on behalf of the client.

The modems shall communicate in the 2.4, 3.6 or 5GHz frequency ranges as specified in the Project Specification *** and shall use Orthogonal Frequency Domain Multiplexing over a spread spectrum of frequencies.

The 802.11b standard shall be provided as a minimum giving a minimum of 11Mbps over the air data communications rate.

An Ethernet Interface consisting of a minimum of one RJ45 socket with data rate of at least 10Mbps shall be provided.

The Ethernet interface shall support Transmitting Control Protocol / Internet Protocol (TCP/IP) as well as all associated data exchange protocols such as HTML, FTP, SSL and TCP/UDP.

The modem shall be supplied in IP42 housing suitable for DIN rail mounting inside a Telemetry panel.

The modem shall have an LED cluster for status indication in the front which is clearly visible from a distance. The LEDs shall display the following as a minimum.

- Power Supply Healthy
- Modem Healthy
- Ethernet port(s) connected (flashing for data transfer)
- Wireless port connected (flashing for data transfer)

Power supply to the modem shall be via an external 230VAC to 5-9VDC adapter suitably rated for the modem. The interface shall be either a DIN DC socket and plug arrangement or a set of screw terminals.

An SMA interface shall be provided on the wireless modem to which either a fixed, removable or wired broadband antenna of 3 dbi gain can be connected.

The antenna may be either directly mounted to the modem where it is installed in the telemetry enclosure or shall be provided with a suitable RF cable and external mounting plate for mounting on top of the enclosure or an outside mast as specified in the Project Specification ***.

The modem shall be supplied with configuration software that can be loaded on a laptop for configuring the modem or the modem shall include an on-board Internet server with HTML configuration pages.

The configuration software shall be password protected and shall allow the configuration f the following:

The channel number shall be selected to be unique in the communications area (number between 1 and 13)

A unique SSID shall be assigned and shall be broadcast for the connection.

The data communications shall be encrypted using the Advanced Encryption Standard with an Open Shared key by the Implementation of WPA security. The key shall be documented and recorded in the Operations and Maintenance manual.

The DHCP service will be disabled and fixed IP addresses configured. These shall also be recorded in the O&M Manual.

1.6 Ancillary Equipment

General:

Each Telemetry installation shall be fully inclusive of all ancillary equipment to make up a fully functional system. Ancillary equipment shall include the power supply to the telemetry system, antennae, masts, radio frequency cabling and system earthing.

The individual items of equipment shall comply with the following:

Power Supply:

Power supply shall be either from a dedicated 230VAC 50Hz single phase supply or a 24VDC battery system as stated in the Project Specification ***.

Batteries: In all cases, the equipment supplied shall operate from secondary batteries to ensure maximum uptime, even during mains failure. The battery voltage may be nominal 12 V or 24 V DC. 24VDC is preferred. All load equipment shall be protected against damage should the supply polarity be inadvertently reversed.

For outstations 1% transmits and 99 % receive/standby duty shall be assumed.

For repeater and base stations 20 % transmit and 80 % receive/standby duty shall be assumed unless otherwise specified in the Project Specification ***.

In repeater stations the battery capacity shall at least be sufficient to operate the equipment without drop in RF output power, for 48 hours.

Lead Calcium or Metal Halide maintenance-free cells shall be used.

Battery Chargers: Battery chargers shall be designed to maximise battery life and effective battery capacity. Preference will be given to intelligent battery management type chargers. Chargers shall not permit the batteries to be overcharged or over depleted.

Mains Supply and Charger: A nominal 230 VAC 50 Hz, single phase supply for the purpose of charging the battery will, wherever possible, be provided by the Client at all sites.

Charger types installed shall be as pre-scribed by the manufacturer of the batteries offered.

The battery charger and other electrical equipment at stations which are supplied by overhead lines of more than 100 m length, shall be protected against mains borne surges to the following levels:

(a) 10 Pulses of 8/20 microsecond shape and 10 kA amplitude applied between Live and Neutral with one polarity;

(ii) Another 10 pulses with the opposite polarity; and
(iii) 10 Pulses, 60 kA, applied in common mode.

All test pulses shall be separated by time intervals of not less than 1 minute.

Both solar and mains chargers shall be equipped with over and under voltage protection as well as fold-back current limiting.

Solar Charger: At selected (e.g. repeater) sites, solar battery chargers may have to be provided. The capacity of these chargers shall be sufficient to allow operation of the system to continue under 80 %-overcast conditions lasting for periods up to two weeks. Allowance shall also be made for the fact that dust and dirt may settle on the solar panels. Solar calculations shall be supplied by the contractor for approval by the Engineer.

Solar panels shall be of the Photovoltaic multicell type and be fitted with a protective cover material that shall be installed in a frame of hot dipped galvanized angle iron at least 3mm thick. The frames shall make it difficult to remove the panels without special tools or shall be lockable.

Solar panels shall be provided with a switch to detect its removal and this signal shall be relayed to the outstation inputs for transmission as an alarm.

Wind Charger: A wind charger shall be sized to suit the application. The wind charger shall be supplied complete with its mounting mast and shall be mounted so that there is no interference with the radio mast. The blades of the propeller shall have at least a 2,5m ground clearance. The blades shall automatically furl in high winds (>16m/s) to govern the speed. The charger shall be equipped with maintenance free sealed bearings. If the charger is mounted above the Snow line the bearing lubrication shall be chosen to operate in sub-zero temperatures.

The charger output shall match the batteries and shall be either 12VDC or 24VDC. In light winds (4 – 8m/s), the charger shall still be capable of delivering a minimum of 10% of rated output.

Alarm Signals: The following alarm signals shall be displayed at the base station for repeater and out stations and the display panel shall indicate the nature of the alarm as well as the number of the repeater or out station:

(I) Low battery voltage
(II) Mains fail alarm (if applicable)
(III) Intruder alarm. This alarm shall operate whenever any door of the equipment building is opened.

The alarm signal shall be transmitted repeatedly at intervals of not more than 1 hour, until the fault has been cleared.

The alarm system shall not give spurious calls.

The alarm encoding equipment at the repeater station shall not be built into the transmitter. Replacement of the transmitter unit shall not disable the alarm system.

Masts and Antennae:

Antennae and mast selection shall be done on the basis of a propagation study as described in section 3.2.5 below.

The type of antennae selected shall also be suitable for the radio communications medium chosen and as specified in the Project Specification *** ie for UHF, GSM and Trunked radio this shall be a dipole whip type or collinear antennae or Yagi-uda type and for spread spectrum radio it shall be a parabolic dish.

The complete structure of antennae and masts for base stations, out stations and repeater stations shall be capable of withstanding steady state or gusting wind velocities up to 160 km/h at 10m above ground level.

Where masts and antennae are erected above the so-called "snow line", they shall additionally be capable of carrying a coating of ice of up to 12 mm thick.

Masts exceeding 8 meters in height shall be either of tubular or lattice construction. All masts sections shall be galvanised in accordance with SABS 763-1977. No drilling, cutting or welding shall be permitted after galvanising. All bolts, washers, nuts, thimbles, turn buckles and similar small parts shall be hot-dipped or otherwise electro- galvanised after machining is completed.

Where riveted mast sections are offered, the riveting shall be carried out at the manufacturer's works employing heated high tensile steel rivets. Cold riveting on site shall not be acceptable.

Tubular mast designs shall employ joints between sections, of the flanged, parallel sleeve socketed or taper sleeve socketed type. Screwed socketed types shall not be permitted. Only bolts and nuts shall be used for construction on site.

Only the best rigging practices shall be acceptable. In all cases where a wire rope has to be made off, thimbles are to be employed. Pressure weld splicing is preferred to the use of Crosby clamps or handmade splices.

Where guy wires are attached to lattice masts, the guy wires shall not pull on the mast legs, but shall be attached to a guy time frame.

In the case of out and base station masts with a total height of less than 9 m, it may be preferable for the manufacturers to offer masts which can be erected and unrigged by the use of an erection kit. This type of mast shall be so designed that the maintenance staff can lower them at will and re-erect them without having to bring special cranes and/or equipment onto site. The masts offered shall therefore be complete with the requisite erection kit.

A safety-climbing device shall be supplied to enable maintenance of the masts and antennae to be carried out. If a caged ladder on the mast is to be used for maintenance purposes, it shall comply with the Occupational Health and Safety Act of 1993. The manufacturer shall supply detachable steps for the first 3 metres of masts above ground level.

When directional antennae have to be mounted on the masts, the brackets and mounting hardware to be used shall allow redirection of the antennae without damaging painted and galvanised mast sections.

Painting (when required by law) shall ensure that all mast sections and members shall be protected by an appropriate number of layers of high quality paint. The paint shall be applied in such a way that no bare metal is exposed on any part of the mast, mast base or guy wires and mounting accessories.

Before painting any piece of metal, the surface shall be properly treated with the necessary reagents, solvents, etching primers and the like to ensure long-lasting protection of the metal surface by the paint.

Paint shall not peel from any section of a mast within a minimum period of two years. If the paint starts to peel off the mast members within the period of time, the contractor shall be required to unrig the mast, remove it to his factory and remove all the paint from the mast. He shall then repaint the mast to the specification, taking

care to apply all the required layers of paint in the correct sequence to the satisfaction of the Engineer, before the mast shall be re-erected on site. This re-painting operation shall be at the expense of the contractor, unless he can prove that the cause of the failure of the paint to adhere to the mast was due to factors beyond his control.

Galvanised mast members shall be treated in accordance with the requirements of SABS method 26 (as far as practically possible) or an equivalent method before any paint is applied to the metal surface.

In the case of non-galvanised mast sections, paintings shall be done according to the SABS 046-1979 specifications.

No section of any mast which is to be set in concrete (i.e. mast base section, holding down bolts, bolt frame, etc.) shall be galvanised. These sections shall be untreated mild steel; all protruding surfaces shall be thoroughly cleaned and painted with bitumen epoxy as per SABS 1200 HC after the footing has cured.
Care shall be taken in handling all mast sections, after unpacking or uncrating, and after removal of protective wrapping, to ensure that no damage is done to painted surfaces.

Navigation lights shall be affixed to the mast structure if so required by the South African Civil Aviation Authority (CAA). The amount and placement of lights shall be according to CAA recommendations. In general masts taller than 30m shall be equipped with navigation lights.

zzz) **Radio Frequency Cabling:**

Cable between the Radio and it's antennae shall be coaxial cable of the low loss foam type with a loss of less than 4dB/100m and an impedance to suit the selected radio medium.

The coaxial cable between the equipment and the antenna shall run down the mast alongside the earth conductor and shall be strapped to the mast at regular intervals. The coaxial cable shall then run underground to the equipment along the route followed by the down conductor to the earth mat, and from there along the ground conductor past the earth bar to the equipment in the building.

High quality outdoor compression type connectors with sealing "O" rings such as the HUBER + SUHNER type shall be used to connect the coaxial cable to the antenna lead. The straps used to tie down the coaxial cable shall not cause any damage to the cable and shall not allow movement of the cable under windy conditions. Insulation tape and cable ties shall not be used for this purpose. Stainless steel "Bandit" strapping shall be used on all outdoor cable runs.

The last two meters of coaxial cable above the ground level shall be run inside heavy duty, galvanised pipe. This pipe shall be sealed at the top where the cable enters and there shall be holes in the bottom of the pipe to drain water, which may accumulate in the pipe.

The coaxial cable shall have no sharp bends in its run from the antenna to the equipment in the building.

Where necessary It may be necessary to bring the coaxial cable across from the mast to the equipment room above ground. This shall be done at a height of more than 2,5 m above ground level. In such cases, a support structure, e.g. cable rack, galvanised conduit or galvanised wire rope catenary, shall be carried across from the mast to the equipment building and the coaxial cable shall be strapped at regular intervals.

The coaxial cable shall run directly to the radio equipment where it shall terminate.

When the coaxial cable enters from above ground level, the earth conductor shall be connected to the equipment at a point close to the termination of the coaxial cable and shall then run directly to the earth bar.

When the coaxial cable enters the building from below ground level, it shall run past the earth bar and from there directly to the equipment. A 10 mm square bare copper cable shall follow the coaxial cable from the earth bar to the equipment where it shall terminate in the immediate vicinity of the coaxial cable connection.

Where the coaxial cable route runs along the face of a wall, the contractor shall run the cable and earth conductor inside a galvanised metal conduit or a galvanised cable rack against the wall.

Precautions shall be taken to limit the potential which may develop across the coaxial cable inner and outer conductors as a result of lightning discharges, even at the expense of a small sacrifice in receiver sensitivity.

The use of earthed entrance panel with in-line polyphaser surge arrestors is mandatory. This panel and arrestors shall be mounted as close to the earth- bar as practically possible, and shall be bonded to the earth-bar with 10 mm² (minimum) copper conductors.

Where a collinear antenna is used, it shall be mounted on a cross-arm at the distance from the mast recommended by the manufacturers for the required polar diagram. The top of the collinear antenna shall also be supported and clamped to the mast with suitable mounting hardware.

Antennae and cross-arms shall be mounted to the masts with suitable clamps. Metal or plastic straps shall not be used for this purpose.

At least one point on each antenna shall be a radio frequency zero potential point, and this point shall be directly connected to the metal work of the mast and the earth system bar. This 10mm² conductors shall run along the same route as the co-axial cable.

Care shall be taken to ensure that dissimilar metals are not clamped together. To clamp aluminium or aluminium-based alloy antenna elements to steel mast sections, galvanized clamp with galvanized bolts, nuts and washers shall be used.

<u>Earthing</u>

Earthing materials and methods used shall conform to SABS 1057.
A trench earth or rod earth shall be provided as a site earth connector at all stations.

Rod earths shall comprise 3 m long molecularly bonded copper clad rods of 13 mm minimum diameter, driven their full length into the ground at a minimum distance of 2 m between adjacent rods.

A copper earth bar of 100 mm² (minimum) shall be mounted against a wall of the equipment room at a point near the RF equipment.

An earth conductor of 70 mm² bare stranded copper shall run from the bottom of the masts lightning spike down the shortest route of the mast, to the site earth and to the earth bar. All connections shall be cad welded or hard soldered.

At no point in the earth ca
ble’s route, from the mast to the site earth, may the earth conductor be bent through an arc with a radius of curvature of less than 500 mm.

If an overhead support structure, which runs from the mast to the equipment building, is to be used for the coaxial cable, then the earth conductor shall also follow this route to the earth bar.

All items of equipment in the equipment room shall be individually connected in a star arrangement to the earth bar with a 10mm² (minimum) copper conductor. All metallic "extremities" of the equipment room, e.g. door and roof, shall be connected to the earth bar in the same fashion.

Equipment mounted inside a metal enclosure or on a metal rack shall be earthed to the enclosure or rack by means of its mounting screws or a separate earth wire. The enclosure or rack shall then be connected to the earth bar as described above.

An earth resistivity test shall be conducted at all installations after completion. If the readings are greater than 10 ohm, extra measures shall be taken to reduce the resistance.

3.2.5. Equipment Installation

The Engineer's proposed telemetry system design shall be refined by the contractor who shall perform a detailed analysis and design for the equipment as per his offer.

The system design shall be confirmed by means of radio propagation studies to confirm the correct equipment choice, installation method, antennae type, mast installation locations as well as quantity of repeaters necessary to provide a fully functional, responsive and reliable telemetry system.

The propagation study shall utilize high qualify topographical data and a reputable propagation simulation software package to verify the above design parameters.

The program shall as a minimum simulate and verify the following:

- Transmitter location
- Transmitter power output
- Frequency
- Antenna Type
- Antenna Pattern
- Antenna Gain
- Transmission line losses, including filters and multicouplers
- Terrain and elevation data for the area

The design shall allow for a fade margin of between 6 to 10dB for outstations and 10 to 20dB for base station and SCADA communications.

The fade margin shall be determined by calculated path loss using actual loss data of all equipment in the system, i.e. Transceiver, connector, RF Cable, antennae and the transmission media etc.

Fresnel zone effect shall be considered in order to minimize diffraction losses and determine optimum antenna mast locations and heights.

Colour coverage plots shall be generated, printed and included in the Operations and Maintenance Manuals together with Geographic information systems charts showing all telemetry equipment locations by name and outstation / base station ID.

1.7 Communications Protocols

General

The telemetry outstations shall communicate with their respective bases stations via an industry standard protocol. Custom protocols and/ or message formats will not be accepted.

All outstation RTU's will as a minimum support both the Modbus RTU and DNP3 protocol however other protocols may also be supported such as MDLC, DFI and Profibus.

The selected protocol shall be clearly documented and all options recorded and include in the Operations and Maintenance manual.

Minimum configurations settings for the most common protocols shall be as follows:

Modbus RTU

Modbus RTU may be considered for small quantity non-critical low speed data telemetry such as to reservoirs.

The complete telemetry system shall be subdivided into base stations and outstations each with a unique Modbus address. The base station shall be configured as the Master and all outstations as slaves.

The master shall poll each slave on a rotation basis and exchange data that has been configured in the RTU for uploading or downloading. The RTU shall buffer all data until polled.

The protocol shall make full use of Cyclic Redundancy error Checking (CRC) however data encryption security and unsolicited data transmission shall not be possible.

A basic network timing prediction shall be done by the contractor and submitted to the Engineer for approval.

DNP3

Distributed Network Protocol shall be considered for critical and high reliability telemetry installations as well as for congested networks where the data throughout and delivery needs to be optimized.

DNP shall also be used where a direct communications with Intelligent Electrical Devices (IED's) is required, such as for example a Pump Station feeder circuit breaker protection control relay.

The implementation of DNP3 shall include full Cyclic Redundancy error Checking (CRC) as well as data security to the IEEE 1379 standard.

The communications strategy implemented shall also make full use of the DNP message class structure such that where throughout needs to be optimized the Class 1, 2 & 3 messages can be configured to take place after Class 0 polls to all outstations. Only in exceptional cases where immediate responses are required from outstations on change of state, shall "report on exception" on Class 1,2 or 3 data be configured in the RTU's.

The DNP configuration strategy and a basic network timing prediction done by the contractor shall be submitted to the Engineer for approval.

IEC 60870

The IEC 60870 protocol shall be selected for highly critical advanced telemetry systems such as electrical substations feeding critical pump stations and treatment works.

IEC60870 shall also be used where more telemetry control as opposed to telemetry monitoring is required. E.g. start/ stop of pump station pumps.

The IEC 60870 protocol shall provide interfaces to Intelligent Electronic Devices (IEDs) that are IEC 60870 compliant.

The protocol shall primarily provide for “report by exception” and “change of state” communications and outstation shall therefore not be polled cyclically.

Addressing of the telemetry stations shall be via Media Access Control (MAC address) which shall be statically assigned and the physical link layer implementation shall be Collision Sense Multiple Access (CSMA) with automatic re-transmission.

IEC 60870 stations shall furthermore include OLE objects associated with each IED which can be used in the SCADA (or OPC server) to access the data and control functions at that outstation.

The complete configuration and parameterization for the IEC 60870 implementation shall be clearly documented and included in the O&M manuals.

1.8 INSPECTION AND TESTING

The contractor’s design in so far as radio propagation studies, selection of transmission medium, radio, transceivers, frequencies, protocols, telemetry panel layouts and wiring diagrams including all ancillary equipment shall be submitted to the Engineer for review and approval.

The assembly of the telemetry panels, ancillary equipment and manufacturing of enclosures as well as mast will be inspected by the Engineer in the factory before being released to site.

The telemetry panels shall be fully tested in the factory which test will be witnessed by the Engineer and the panel approved before being released to site.

Radio propagation and system response time shall be tested on site by the contractor and reports of all signal strengths, data throughput and re-transmission error rates shall be made and submitted to the Engineer for review. Any system not meeting the performance requirement shall be corrected by the Telemetry contractor at his or her own expense by either the alteration of chosen equipment, output power, mast arrangements and/or addition of repeater stations.

Copies of all test results and equipment certifications shall be included in the Operations and Maintenance manuals.

F258 – STANDARD SPECIFICATION FOR ELECTRONICS COMMISSIONING

SCOPE

This part of the standard specification gives detailed technical specifications which apply to the commissioning of electronic installations. This specification does not apply to field instrumentation applied within Safety Instrumented Systems or within classified, hazardous areas.

NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

ISA-5.1 – Instrumentation symbols and identification
ISA-5.4 – Instrumentation loop diagrams
ISA-7.0.01 – Quality standard for instrument air
ISA-20 – Instrumentation forms for process measurement and control instruments
ISA-75.01 – Control Valve Sizing Equations
SANS/IEC 60529 – Degrees of protection provided by enclosures (IP code)
SANS 10142-1 – The wiring of premises, Part 1: Low-voltage installations

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

I to P – Current to Pressure
NPT – National Pipe Thread
BSP – British Standard Pipe Thread
FSD – Full Scale Deflection
NP – Nominal Pressure
DCS – Distributed Control System
SCADA – Supervisory Control and Data Acquisition

GENERAL

The Contractor, supplier and vendor of all instrumentation shall adhere to the Quality Assurance Manual for the commissioning of electronic installations.

This commissioning procedure shall be based on the following guiding principles:

- All major equipment e.g. MCC's, PLC's and SCADA systems have been suitably tested in the factory (FAT's) and defects have been corrected.
- The Contractor will be responsible for performing all checks and witnessed by the Engineer on an ad-hoc basis.
- The Contractor will be responsible for producing all commissioning documentation as per the QA plan, standard and detailed specifications
- No piece of mechanical equipment e.g. a pump shall be operated unless the mechanical equipment installation has been approved by the Mechanical Engineer and the equipment motor starter has been approved by the Electrical Engineer as well as records of commissioning have been issued.

PHASED COMMISSIONING PROCESS

A phased commissioning process shall be followed as described below:

- Commissioning of power supply e.g. MV
- Commissioning of power supply to MCC's and PLC panels i.e. LV
- All PLC I/O cards shall be switched off at this point to allow for the field connection of instrumentation and other I/O signals
- Commission the wiring between all field instrumentation and the PLC Panel
- Switch on PLC I/O cards in a systematic manner
- Commission instrumentation loops i.e. analog and digital instruments
- Commission PLC HMI's
- Commission mechanical equipment e.g. pumps and perform direction tests are required
- Commission SCADA system
- Run the plant (per stream) with the absence of product to check interlocks and control loops
- Run the plant (per stream) with the presence of product to check operation and performance of equipment

Run the plant (all streams as designed) with the presence of product to perform performance tests

No piece of mechanical equipment e.g. a pump shall be operated without liquid. Pumps must be un-coupled from the drives for direction testing. No piece of mechanical equipment e.g. a pump shall be operated unless the equipment motor starter and associated instrumentation interlocks have been checked and approved by the Electrical Engineer.

FIELD INSTRUMENTATION COMMISSIONING

Field instrumentation will be inspected firstly by checking the installation in accordance with the checklists provided in this document and the installation drawings. This will be followed by powering up of the instrument and simulation of signals to the PLC and SCADA system. Once these checks are completed, the actual signal in terms of measuring range, interlocks and alarm settings will be commissioned to the PLC and SCADA system. The following shall be adhered to:

- All instruments, except where impractical to check, shall have a bench calibration check prior to installation, in accordance with the latest specification sheet and manufacturer's recommendations, and are visually checked for any damage.

- The results of these checks shall be tabulated, with all other information, on the "Instrument Calibration Sheet", as each instrument is being tested.

- Any faults found with an instrument, which cannot be readily corrected, shall be reported and the Contractor shall arrange for repair or replacement. It shall be the Contractor's responsibility to familiarize himself with the type and operation of all instruments.

- After a loop is complete and has been accepted, and power is available, that loop will be simulated (function tested) for correct operation.

- This will basically involve the following:

    - Cold commissioning, i.e. testing without electrical power applied to the loop as per commissioning sheets.

    - Hot commissioning, i.e. testing with electrical power applied to the loop as per commissioning sheets.

    - Binary inputs from field and outputs from PLC shall be operated to ensure, solenoids, etc. function according to specifications.

    - Transmitters shall be function tested (not calibration) or, where this is not possible, tested using a transmitter simulator at the transmitter terminals, or millivolt source for thermocouples / RTD's.

    - Transmitted signals shall be checked to ensure the correct signal is indicated on the relevant equipment and systems. The display shall appear on all relevant HMI and SCADA mimics/lists.

    - Alarms and trips in each loop shall be checked to ensure they operate with the transmitted signal at their correct setting, giving the correct action and interlocking requirements wherever applicable.

    - Where PID control functions exist, the control action (dependent upon control valve fail safe action), valve tags and any limits shall be checked and set. The controller gain should be set to 1, and integral time to 20 sec. (If derivative is included this can be set to 0 sec). Using the transmitted signal and the set point adjustment, an open loop controllability check shall be made on both sides of the set point.

- Control valves shall be stroked from the operator interface and any valve accessories shall be checked.

- Special attention shall be paid to sequences interlock, trip and alarm points and that these are handled according to the alarm class allocated.

- All checking/testing information shall be documented by the Contractor on the sheets provided.

- Where a loop has been previously tested and any instrument in that loop subsequently removed, that loop shall be function tested again when the instrument is replaced.

When a control loop is required to be put "on-line", each item shall be commissioned in the correct sequence. The control loops shall be switched to "Auto" when required to tune for optimum performance. This will require various load changes up to maximum to ensure overall load controllability and correct interaction with other control loops of systems. Also, the plant load will be required to be reduced to check the minimum possible, on fully automatic control.
All instruments setting and readings, together with outputs shall be logged for future reference.

All process alarms and trips shall be physically taken to their switch points to ensure that they supply the correct information and perform the required safety action.

After acceptance of the Instrument Installation and subsequent commissioning, all test documentation and marked up "As Built" prints of the installation drawings shall be used for updating of the original drawings/documentation.

ELECTRICAL STARTER COMMISSIONING

At this point in time, all electrical starters shall have already been commissioned satisfactorily at the Factory and the final checks will concentrate on the operation of the MCC once connected to the field stop/start stations and the actual electric motor/feeder loads.
The installation will be inspected to ensure that all field starters and loads are terminated in accordance with the installation drawings. This will be followed by powering up of the equipment and operation of each starter circuit. The following shall be adhered to:

- All modes of control will be checked
- All safety interlocks (hardwired) will be checked during operation
- All process interlocks will be checked during operation
- Operation will be checked from the MCC panel
- Operation will be checked from the HMI
- Operation will be checked from the SCADA system

Full mechanical and process commissioning shall follow the successful completion of the instrumentation and control system commissioning.

Commissioning certificates shall be provided, by the Contractor for as per the templates contained in this standard.

COMMISSIONING DOCUMENTATION

The following working versions of documentation shall be produced by the Contractor prior to the request for Practical Commissioning:

- P&ID's
- Instrumentation list
- PLC I/O list
- Plant control philosophy
- PLC FDS
- SCADA FDS
- Equipment location drawings
- Control system network architecture
- Cable schedule including all cable lengths
- Instrumentation installation checklists (completed by the Contractor)
- Electronic equipment installation checklists i.e. PLC/SCADA/networks etc. (completed)
- Electrical panel CoC's
- Cable tests certificates (completed)
- Fibre Optic Cable test certificates (completed)
- Draft O&M Manuals

The following final versions of documentation shall be produced by the Contractor prior to the request for a Certificate of Completion:

- P&ID's
- Instrumentation list
- PLC I/O list
- Plant control philosophy
- PLC FDS
- SCADA FDS
- Equipment location drawings
- Control system network architecture
- Cable schedule including all cable lengths
- Instrumentation installation checklists (completed by the Contractor)
- Electronic equipment installation checklists i.e. PLC/SCADA/networks etc. (completed)
- Electrical panel CoC's
- Cable tests certificates (completed)
- Fibre Optic Cable test certificates (completed)
- Final O&M Manuals

COMMISSIONING CERTIFICATION – CABLING INFRASTRUCTURE

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Cabling Infrastructure installation)

RECORD OF COMMISSIONING (CABLING INFRASTRUCTURE INSTALLATION)				**CR**
Project:	FWF De-Watering Plant	Order No.:	NA	
Contract No.:		Date of Inspection:	22/02/2016	
Equipment Tag:		Item Inspected	Cabling Infrastructure	
Equipment Description:		Section		

Description	Completed
Checkpoints:	
1. Cable racks and ladders are secure to structures and to each other	
2. Cable racks and ladders are equipotentially bonded with fit for purpose insulated conductors	
3. Cable racks and ladders have no sharp edges	
4. Cable racks and ladders are not over-loaded and have sufficient capacity for future installations	
5. Cable racks are numbered in accordance with the cable racking drawings	
6. Cables racks and ladder penetrations are sealed at building points of entry and exits	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – CABLE INSTALLATION

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**
Record of Commissioning (Cable Installation)

RECORD OF COMMISSIONING (CABLE INSTALLATION)	**CI**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Cable Installation
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. All cables are installed on suitable supports	
2. All cables are tagged in accordance with the installation drawings and cable schedule	
3. All cables are glanded correctly with no possibility of water ingress	
4. There is suitable clearance (300mm) between power and control/communication cables	
5. All cables are strapped to racks/ladders neatly	
6. There are no kinks/bends or physical damage to any cable	
7. There are no exposed parts of cables evident	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – ANALOG INSTRUMENT INSTALLATION

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Analog Instrument Installation)

RECORD OF COMMISSIONING (ANALOG INSTRUMENT INSTALLATION)	**AI-I**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Analog Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Is the instrument installed according to the manufacturer's recommendations?	
2. Are the cables neatly strapped and away from electrical cables?	
3. Are cable glands tight and sealed, and covered with shroud (where applicable)?	
4. Are cable numbers fitted and according to standard?	
5. Are equipment labels fitted and conform to standards?	
6. Are terminal numbers fitted and does it correspond to numbers on individual wires and associated loop drawing?	
7. Has wiring continuity been tested from terminal to terminal?	
8. Has earth continuity been checked?	
9. Are cable screen wires earthed at the PLC panel only?	
10. Is loop polarity correct?	
11. Has a calibration bench check been done and calibration sheets available?	
12. Is the equipment adequately protected from mechanical damage?	
13. Are the specification/datasheets sheets of the equipment available?	
14. Does the actual field wiring and installation loop drawing match?	
15. Are the manuals of the instrument available?	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – ANALOG INSTRUMENT PRE-COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**
Record of Commissioning (Analog Instrument Pre-Commissioning)

RECORD OF COMMISSIONING (ANALOG INSTRUMENT PRE-COMMISSIONING)	**AI-P**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Analog Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check loop simulation to PLC	
2. Check instrument range	
3. Check and record the supply voltage	
4. Check simulation value on SCADA alarm limits (low-low)	
5. Check simulation value on SCADA alarm limits (low)	
6. Check simulation value on SCADA alarm limits (high)	
7. Check simulation value on SCADA alarm limits (high-high)	
8. Check simulation value on interlock behaviour	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – ANALOG INSTRUMENT COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Analog Instrument Commissioning)

RECORD OF COMMISSIONING (ANALOG INSTRUMENT COMMISSIONING)	**AI-C**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Analog Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check actual value to PLC	
2. Check SCADA value	
3. Check and verify alarms	
4. Check and verify interlocks	
5. Check and verify loop operation	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – DIGITAL INSTRUMENT INSTALLATION

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Digital Instrument Installation)

RECORD OF COMMISSIONING (DIGITAL INSTRUMENT INSTALLATION) DI-I

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Digital Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Is the instrument installed according to the manufacturer's recommendations?	
2. Are the cables neatly strapped and away from electrical cables?	
3. Are cable glands tight and sealed, and covered with shroud (where applicable)?	
4. Are cable numbers fitted and according to standard?	
5. Are equipment labels fitted and conform to standards?	
6. Are terminal numbers fitted and does it correspond to numbers on individual wires and associated loop drawing?	
7. Has wiring continuity been tested from terminal to terminal?	
8. Has earth continuity been checked?	
9. Are cable screen wires earthed at the PLC panel only?	
10. Is the wiring polarity correct?	
11. Has a calibration bench check been done and calibration sheets available?	
12. Is the equipment adequately protected from mechanical damage?	
13. Are the specification/datasheets sheets of the equipment available?	
14. Does the actual field wiring and installation loop drawing match?	
15. Are the manuals of the instrument available?	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – DIGITAL INSTRUMENT PRE-COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Digital Instrument Pre-Commissioning)

RECORD OF COMMISSIONING (DIGITAL INSTRUMENT PRE-COMMISSIONING) — DI-P

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Digital Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check simulation to PLC	
2. Check and record supply voltage	
3. Check and verify behaviour within interlock logic	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – DIGITAL INSTRUMENT COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Digital Instrument Pre-Commissioning)

RECORD OF COMMISSIONING (DIGITAL INSTRUMENT PRE-COMMISSIONING) — DI-C

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Digital Field Instrument (Input)
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check actual value to PLC	
2. Check actual value to SCADA	
3. Check and verify alarms	
4. Check and verify interlocks	
5. Check and verify loop operation	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – VALVE INSTALLATION

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Automatic Valve Installation)

RECORD OF COMMISSIONING (AUTOMATIC VALVE INSTALLATION) AV-I

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Automatic Valve
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Is the instrument installed according to the manufacturer's recommendations?	
2. Are the cables neatly strapped and away from electrical cables?	
3. Are cable glands tight and sealed, and covered with shroud (where applicable)?	
4. Are cable numbers fitted and according to standard?	
5. Are equipment labels fitted and conform to standards?	
6. Are terminal numbers fitted and does it correspond to numbers on individual wires and associated loop drawing?	
7. Has wiring continuity been tested from terminal to terminal?	
8. Has earth continuity been checked?	
9. Are cable screen wires earthed at the PLC panel only?	
10. Is the wiring polarity correct?	
11. Has a calibration bench check been done and calibration sheets available?	
12. Is the equipment adequately protected from mechanical damage?	
13. Are the specification/datasheets sheets of the equipment available?	
14. Does the actual field wiring and installation loop drawing match?	
15. Are the manuals of the instrument available?	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – VALVE PRE-COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Automatic Valve Pre-Commissioning)

RECORD OF COMMISSIONING (AUTOMATIC VALVE PRE-COMMISSIONING)	**AV-P**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Automatic Valve
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check open and close operation of valve from SCADA system	
2. Check intermedian (between 0-100%) operation of valve in manual mode from SCADA system	
3. Check and verify behaviour within interlock logic	
4. Check and simulate all alarms/feedback signals to PLC and SCADA system	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – VALVE COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (Automatic Valve Commissioning)

RECORD OF COMMISSIONING (AUTOMATIC VALVE COMMISSIONING) AV-C

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	Automatic Valve
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Check actual feedback values to PLC	
2. Check actual feedback signals to SCADA	
3. Check and verify alarms	
4. Check and verify interlocks	
5. Check and verify loop operation	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – PLC PRE-COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (PLC Pre-Commissioning)

RECORD OF COMMISSIONING (PLC PRE-COMMISSIONING)	**PC-P**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	PLC
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. PLC installed in accordance with manufacturer's specifications	
2. PLC Panel has been earthed	
3. PLC screen bar is installed and not connected to electrical earth	
4. The correct software version has been installed	
4. PLC is in 'run' mode	
5. Check for no errors in CPU/PSU or other modules	
6. Check and verify inter-PLC communications	
7. Check and verify PLC-SCADA system communications	
8. Control system architecture drawing represents the actual installation correctly	
9. All inter-connecting cables, terminals, terminal strips and other equiment and labelled correctly	
10. PLC battery is installed	
11. PLC associated HMI is installed and communicating	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

OMMISSIONING CERTIFICATION – PLC COMMISSIONING

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (PLC Commissioning)

RECORD OF COMMISSIONING (PLC COMMISSIONING)	**PC-C**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	PLC
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. PLC is in the 'run' mode with no errors	
2. All instrumentation read-outs are correct on the HMI	
3. All equipment can be stopped and started in Manual Mode from the HMI	
4. All alarms on the HMI are functional	
5. All events on the HMI and functional	
6. PLC continues to operation in 'run' mode in the event of failure of HMI communications	
7. PLC continues to operation in 'run' mode in the event of failure of SCADA communications	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required — On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

COMMISSIONING CERTIFICATION – SCADA INSTALLATION

OPERATIONAL PROCEDURE QS903/F16 : Issue 2 Page 1 of 6

Subject : **Contract Administration** **Authorised:**

Record of Commissioning (SCADA Installation)

RECORD OF COMMISSIONING (SCADA INSTALLATION)	**SA-C**

Project:	FWF De-Watering Plant	Order No.:	NA
Contract No.:		Date of Inspection:	22/02/2016
Equipment Tag:		Item Inspected	SCADA
Equipment Description:		Section	

Description	Completed
Checkpoints:	
1. Power up all SCADA components and verify the absence of any hardware faults	
2. Check all servers and Operator Stations are communicating	
3. Check all Ethernet switches for faults	
4. Check each Operation Station for menu navigation and mimic loading	
5. Check that all mimics are 'live'	
6. Check all Alarm Pages on each Operator Station	
7. Check all event log pages on each Operator Station	
8. Check all trend pages on each Operator Station	
9. Check all reports are being generated	
10. Check Remote/Manual operation of all equipment	
11. Check Automatic operation of all equipment	
12. Check correct operation of all mimics	

Description	Completed
Result of Check:	
1.	
2.	
3	
4	
5	
6	
Notes:	
1.	

Acceptance of Corrective Action Required On behalf of Manufacturer/Site Official

Signature: Name: Date:

Items released by Royal HaskoningDHV for further work or accepted for dispatch to site.

Signature: Name: Date:

Corrective action completed by contractor

Signature: Name: Date:

Corrective Action Accepted by Royal HaskoningDHV

Signature: Name: Date:

F259 – STANDARD SPECIFICATION FOR CONTROL PHILOSOPHY DOCUMENTS

1. SCOPE

This part of the standard specification gives detailed technical specifications which apply to the authoring of control philosophy documents applicable to automation systems.

2. NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

IEC 61131 – Programmable Logic Controllers (All parts)

ISA 18.2 – Management of Alarm System for the Process Industries

ISA 88.00 – Batch Control (all parts)

ISA 95 – Enterprise-Control System Integration (all parts)

ISA 99 – Security for Industrial Automation and Control Systems

3. DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

SCADA – Supervisory Control and Data Acquisition

PLC – Programmable Logic Controller

CPU – Central Processing Unit

HMI – Human Machine Interface

I/O – Input/output

DCS – Distributed Control System

SCADA – Supervisory Control and Data Acquisition

FDS– Functional Design Specification

4. GENERAL

A Control Philosophy document is a document that describes, in detail, how the plant must be controlled in order to meet all functional and performance requirements. It is compiled by the Contractor who will have designed the plant and approved by the Engineer before any software configuration occurs. The documents shall reference the PFD’s, P&ID’s and instrumentation list.

5. FORMAT

A Control Philosophy document shall comply with the format below and include the requirement information:

4.1 General

Introduction

Applicable Drawings {List all drawing applicable e.g. PFD's, P&ID's vendor drawings etc.}

Applicable Documents {List all applicable documents e.g. Motor lists, instrument lists etc.}

Definition of Control Modes {Define all control modes, e.g. local/remote, Manual, Auto, Cascade etc.}

Definition of Interlocks:
- Safety Interlocks
- Primary Interlocks
- Secondary Interlocks

Definition of Alarm Types {Define alarm types e.g. Warning, Urgent, critical etc.}

4.2 Material Flow

Plant: Describe the flow of all material through the plant

Plant Sub-Systems: Describe the flow of material through each piece of process equipment e.g. Degritter etc.

4.3 Plant Control

Plant Control: Description of the overall plant control required

Plant Control: Description of how each piece of process equipment is to be controlled

Plant Control: Description of plant start-up and shut-down sequences

Plant Control: Description of all control loops e.g. PID loops, cascade loops etc. All set-point must be defined.

4.4 Interlocks

Interlocks: Description of all process interlocks required

4.4 Alarms

Alarms: Description of all process alarms required

4.5 Process Value Logging, Trending and Reporting

Process Values: Logging, trending and reporting

4.6 Appendices

Appendix A: Motor List
Appendix B: Field Instrumentation List

F260 – STANDARD SPECIFICATION FOR P&ID's

SCOPE

This part of the standard specification gives detailed technical specifications which apply to the drafting of P&ID's.

NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this section of the standard and contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard shall take the necessary steps to ensure the use of the most recent editions of the standards indicated below:

ISA 5.1 – Instrumentation Symbols and Identification
ISA 5.4 – Instrumentation Loop Diagrams

DEFINITIONS, ABBREVIATIONS AND ACRONYMNS

P&ID – Piping and Instrumentation Diagram
CAD – Computer Aided Drafting
SCADA – Supervisory Control and Data Acquisition
PLC – Programmable Logic Controller
CPU – Central Processing Unit
HMI – Human Machine Interface
I/O – Input/output
DCS – Distributed Control System
SCADA – Supervisory Control and Data Acquisition
FDS– Functional Design Specification
VFD – Variable Frequency Drive
ISA – International Society of Automation
FC/FO – Fail Closed, Fail Open
PRV – Pressure Relief Valve

GENERAL

All P&ID's produced for the project shall comply with this specification. The visual requirements shall provide a balance between the desire to show all data on P&IDs with the need to make P&IDs legible and easy to read. Many details that are available from other types of documentation (e.g., instrument loop diagrams, vessel data sheets etc.) are not recommended to be included on P&IDs.

Database driven packages e.g. Bentley AutoPlant, AutoCAD P&ID, Dessoft etc. are preferred over standard CAD drafting packages.

P&ID FUNCTIONS

The P&ID is used by all of the disciplines to detail the components needed to make the process operate as intended.

The process designers develop all of the routing for pipes, pumps, valves, etc. The equipment (mechanical) engineer then selects his/her equipment in consultation with the process and piping engineers to ensure that process objectives can be met. Once these items have been developed, the instrumentation engineer develops how the process is to be monitored/controlled.

This task requires some overlap with the process engineer and the piping designer. As an example, chlorine residual data of water leaving a filter is a state and national monitoring requirement to ensure proper treatment. In this situation, the process engineer normally determines that some form of chlorine residual measurement is needed, while the instrumentation engineer determines what method of analyzer will be used. The piping designer will develop input for the location of sample piping, where the sample will be drained to after it is taken, the valves on the analyzer for isolation and maintenance and other items (such as pressure regulators or gages) to facilitate proper operation. The electrical engineer is concerned with power and process control wiring for the various pieces of equipment in the facility. In the chlorine residual example, the electrical engineer would want to know if the transmitter requires 220VAC (or if it is a loop powered device) and he/she would want to know where the signal is wired to (distributed control system or a local control panel). All of this information is then depicted on the P&ID.

The P&ID shall display the following information as a minimum:

- Material flow
- Process Unit process operations
- Piping between the various sections of the plant and process equipment. Piping on a P&ID may include instrument connections or heat tracing depending upon the size of the project.
- Major pieces of mechanical equipment (pumps, vendor packages, filters, clarification equipment, tanks, etc.).
- Valves and directions of process flow
- Field Mounted Instruments
- Electrical equipment- The P&ID often shows major pieces of equipment that require either signal or power wiring e.g. Motors, VFD’s etc.
- Communications links

P&ID DRAWING SIZE

P&ID drawing sizes shall be 841 mm x 594 mm (A1 size). All P&IDs drawings shall conform to this size. It may be required to scale fixed size equipment symbols under certain circumstances due to P&ID density or other factors. This must be done using suitable procedures for scaling of symbols and not by resizing. Resizing of fixed size equipment symbols shall not be done as a norm, but rather as an exception.

P&ID DRAWING LAYOUT

The layout of each P&ID shall be uncluttered and allow for future modifications. No more than ten items of major equipment shall be drawn per P&ID. A set of pumps in the same service is considered as one item of equipment for the purpose of the P&ID layout.

The primary ‘Process Flow’ on each P&ID shall be depicted from left to right.

The inlet and outlet of equipment shall be drawn relative to the actual equipment layout (e.g., cooling water supply at the bottom of an exchanger, while tube bundle and cooling water outlet at the top of an exchanger).

Primary process lines shall be distinguished from secondary process, and utility lines. This distinction shall be detailed in the Lines and Layering Section.

Off-page ‘Service Descriptions shall display the following information:

- P&ID number and origin/destination
- Name of fluid (e.g., Process Water) or line description Feed, Tower Overhead)
- Line function (e.g., Low Level Override) or controlled (e.g., PV-10014A/B) for instrument

Service description and origin/destination text shall start at the left hand side of the off-page connector symbol.

Utility connectors may be shown at any convenient location on the body of the P&ID.

Utility collection/distribution P&IDs layout shall be drawn relative to ‘plot plan’ orientation.

When match lines are required on Utility P&IDs, they shall correspond to the matching lines of the connecting drawing.

Equipment symbols shall be arranged relative to their elevation (e.g., pumps at bottom of P&ID).

Control valve actuators shall be drawn above a horizontal line or left of a vertical line, whenever possible.

Compressors, and Hydraulic Pack's piping, instrumentation, and auxiliaries shall be drawn on a separate auxiliary P&ID.

STANDARD COVER SHEETS

A standard cover sheet shall be included which will contain an illustrated summary of all symbols and conventions used.

The complete set shall consist of the following information:

- Mechanical equipment symbols
- Mechanical equipment numbering convention
- Line numbering convention
- Pipe Product codes
- Pipe Material codes
- Valve Conventions
- Instrument and lines symbols
- Instrument Tag numbering convention
- Letter identification Table
- Miscellaneous equipment symbols
- Typical instrument's configuration layout

LINES AND LAYERING

The recommended layers for plotting on original drawing A1 size is provided below:

Name	Colour	Line Thickness	Description
Layer 1	Green	0.7mm	Equipment & Major process lines
Layer 2	Magenta	0.35mm	New major pipelines
Layer 3	Red	0.5mm	Minor Process Lines
Layer 4	Yellow	1.0mm	Major Process lines
Layer 5	Grey	0.12mm	Arrows & Borders
Layer 6	White	0.25mm	General
Layer 7	Cyan	0.25mm	Text & Utility Lines
Layer 8	Blue	0.35mm	Borders

Line thickness shall be adjusted when P&IDs are plotted in smaller size.

Existing equipment and Instrumentation need to be indicated in dotted lines as opposed to solid lines.

Flow arrows at corners and intersecting lines, where there is a change in direction in the major flow must be shown.

Break vertical primary process lines when crossing horizontal primary process lines.

Break secondary and utility lines for primary process lines.

Break vertical secondary and utility lines for horizontal secondary and utility lines.

Break instrument lines for all process and utility lines.

For utility collection/distribution P&IDs, break entering and exiting lines around Pipe rack lines.

Maintain line break gaps at 3 mm.

Avoid routing lines across equipment or text.

TEXT

The recommended text heights for plotting on original drawing A1 size is provided below:

Element Type	Height (mm)	Weight (mm)
General Text	2	0.25
Equipment Tags	3	0.35
Equipment Title	2.5	0.25
Line Numbers	2	0.25

General text and notes are aligned left and start in the upper left corner of the notes area.

Show equipment text top/center justified.

When a note contains more than one line, show line spacing between each line at 1 mm.

Show spacing between notes at 1 mm beneath the last line of the preceding note maintaining top/left text justification.

Show text horizontal where possible.

Show vertical text placed to the right of supporting graphics where possible.

Read vertical text only from the left/bottom.

Show line numbering with the orientation of the line.

Show control valve failure action abbreviation 1.5 mm directly below control valve.

INSTRUMENTATION BUBBLES

The specific configuration requirements with respect to instrumentation bubbles depicted on P&ID's is as follows:

The area and equipment number must be displayed next to the instrument bubble.

Instrumentation device and function symbols shall be as per the ISA 5.1 standard as a minimum.

Multiple instruments of the same type, indicated with a suffix A, B, C, etc. all require individual instrument bubbles as per ISA.
Each and every instrument (hand switches, indicator lights, etc.) needs to be indicated on the P&ID. Exclusion of any item from the P&ID shall exclude the item from design and procurement.

Local control boxes need to be indicated as field mounted bubbles (double line).

Graphical grouping of associated bubbles may be done using dash-dot or similar line type (E.g. control boxes, UPS signals, etc.)

All Identification letters shall be as per the ISA 5.1 standard as a minimum.

EQUIPMENT REPRESENTATION

The specific configuration requirements with respect to equipment depicted on P&ID's is as follows:

Show equipment symbols with simple outline representation. Exercise discretion so that equipment symbols do not dominate the drawing, but draw the symbols large enough for clear understanding. Do not draw equipment to scale. Show equipment relative to one another both in size and general orientation.

Show nozzles on equipment, including spares, as single lines. Show manholes as double lines. Do not label process and utility nozzles. Show nozzle sizes unless the size is implied by piping connections.
Equipment's symbol that is not specifically identified in this standard shall be drawn with reasonable depiction of the actual equipment that is installed at the field.

Equipment shall include as a minimum: Equipment Number and Title/Service as a minimum.

Equipment's internals (normally non-visible) shall be depicted as dashed lines. Details of internals features that have no significant bearing on the piping design and layout or equipment operation shall be omitted.

Do not show equipment elevations unless they are necessary to specify process requirements for associated equipment location or orientation relative to one another.

Show associated trim for vent, drain valves, instrument bridles.
Show jacketing requirements for equipment.

EQUIPMENT DATA [SPECIFIC REQUIREMENTS]

The specific configuration requirements with respect to equipment data on P&ID's is as follows:

Show blower symbols as centrifugal or positive displacement as required.

It is recommended that if a suitable chute is not in the library, that the specific chute is drawn manually and assembled into a symbol for the P&ID. If the chute is more than a once-off requirement, then the chute drawing shall be sent to the responsible parties for inclusion in the library.

Show the compressor symbol for each stage of multistage compressors. Multistage compressors may be shown on multiple P&IDs, but appropriate cross reference shall be made.

Each item of driven equipment shall have a motor symbol attached, which is assigned a motor tag name. The instrument bubble (MC…) is then attached to the motor symbol. The motor tag name may be switched off from the P&ID (by using attribute visibility and selecting the text component and unselecting the number check box) so as not to clutter the P&ID. The motor symbol acts as a visual aid and generates a motor list, which may be used for procurement purposes. Consistency in this application is essential to ensure correctness of the motor list.

Packaged equipment shall be drawn in its entirety.

PIPING

The specific configuration requirements with respect to pipes indicated on P&ID’s is as follows:

Show the line data identification.

Do not use suffixes as part of the sequence number.

Sequence numbers typically originate and terminate at equipment. Assign different sequence numbers to line branches that terminate at different equipment numbers or lines.

Do not change the sequence number when the line flows through a Piping specialty item or a control valve or when there is a line class break.

Assign different sequence numbers to the inlet and outlet of pressure relief valves.

Show insulation code changes.

Show special layout requirements (e.g., No Pockets) with a note.

Line Service Codes shall be included and these shall consist of one to three alpha characters.

VALVES

The specific configuration requirements with respect to valves indicated on P&ID’s is as follows:

Show valve symbols per the ISA symbol list for valves.

Show all valve symbols as full size. Do not show reduced size valve symbols for drain and vent valves.

Do not show valve size unless the size cannot be clearly identified from the P&ID.

Use the listed ISA valve symbols for defining control valve body types. If the control valve body type is unknown, use a gate valve or rotary valve symbol as the generic symbol.

Use a note or symbol to specify a valve’s required installation/orientation when necessary (e.g., valves with a vented ball/disc).

Show valves per the ISA symbol list. The symbols for automated valve bodies and for manual valves are identical. Use the appropriate actuator symbols (e.g., diaphragm and piston) to distinguish automated valves from manual valves.

Show automated valve fail actions with text (FC/FO/FL/FI) per ISA. Using stem arrows as outlined in ISA is not recommended.

For multi-port automated valves, use FL and FI where appropriate. Do not use FO and FC. Use arrows to show fail position flow paths. Note that multiple arrows may be required. Valves that have different fail actions for loss of signal and for loss of motive power require an explanatory note.

Show valve body sizes for all automated valves if not line sized or otherwise implied.

Do not show automated valve specifications or commodity codes.

For automated valves, identify tight shut-off requirements, by using the abbreviation “TSO”.

Do not show valve identifying tags with bubbles when the associated loop tag is readily apparent. Show an identifying tag with a bubble for split range valves, self-contained regulators or valves located on a separate P&ID from its controller.

Show the ranges (e.g., 0-50%, 50-100%) for split range control valves. The preferred labeling is controller percentage output since it applies to both pneumatic and electronic systems.

Do not show valve positioners unless necessary to clarify loop operation (e.g., when used with trip solenoids or pneumatic trip relays). When shown, valve positioners are normally included with the automated valve symbol and are not tagged.

If current to pneumatic converters (I/Ps) are used, show them with a bubble symbol, tag and function box.

Show all solenoids that actuate final control elements (e.g., trip valves and pneumatic relays).

Show solenoid valve fail actions using a directional arrow indicating the open flow path when de-energized. Note that a 4-way solenoid valve requires two directional arrows to adequately define the flow paths. Show resets (manual or remote) if included with the solenoid valve.

Show automated valve auxiliaries (e.g., hand wheels, volume tanks, nitrogen back-up bottles). The use of typical details should reduce clutter.

Use a note to identify the need for valve travel stops.

Show normally closed manual valves using a darkened solid symbol.

When darkened in valves cannot be used because of symbol type (e.g., butterfly valve), use the abbreviation for Normally Closed (NC) directly below the valve in a horizontal line or to the right of the valve in a vertical line.

Show on-off valves in normal operating position. Do not show control valves or relief valves normally closed.

INSTRUMENTATION SYMBOLS AND IDENTIFICATION

The specific configuration requirements with respect to valves indicated on P&ID’s is as follows:

A standard instrumentation symbol list, contained in most intelligent database drive packages shall be used.

The ISA standard for instrumentation tagging shall be used in all instances.

Interlock symbols shall be depicted as follows:

- For discrete, hardware-based interlocks, use the conventional diamond symbol per ISA.
- For PLC-based interlocks, use the diamond-in-a-box symbol per ISA
- For DCS-based interlocks, use the DCS symbol (circle-in-a-box).
- For PLC's integral to the DCS, use the PLC symbol (diamond-in-a box).

Use directional arrows on instrumentation signal lines only when the function is not obvious (e.g., cascades, selectors, interlocks).

Instrument Function Symbols, are used to clarify the function of certain tagged instrument bubbles. The symbol is placed outside the bubble at the upper right.

Use the off-page connector to depict continuation of instrumentation signals from one P&ID to another.

Do not show any individual instrument bubble more than once, unless needed to clarify operation of the loop. If an instrument bubble must be shown more than once, then the succeeding occurrences are shown as dotted.

Show Instrument Line Symbols per ISA.

Show all transmitters to avoid misinterpretations of physical and wiring connections between the transmitter and other devices or systems.

Show dip tubes, bubblers and still-wells for both process and instrumentation. Add notes for relevant specifications, materials, dimensions, weep holes; spray heads, etc. as required.

Show flow meters with the appropriate ISA symbol. If no unique symbols exist or if a device type is unknown, then use a generic symbol and provide a text label to identify the measurement type. Provide a tag for all in-line generic flow meter bubbles. Show a bubble with loop tag for other flow meter element symbols only if the loop association is not readily apparent.

Show the size of all in-line devices if not line sized or otherwise implied.

Do not show flow meter accuracies. Use of a note to indicate a special meter requirement is optional.

If used, flow conditioning devices (e.g., straightening vanes) are labeled with an instrumentation tag (e.g., “FX-…”) associated with the flow measurement loop.

Do not show ISO-9000 or other quality designations.

Show a symbol and tag for a thermo well if it is a stand-alone, spare or test well.

Do not show thermo well symbols or tags if a thermal measuring element is connected to it unless the loop association is not readily apparent. If a bare element is necessary (no thermo well), then a note or text label (e.g., BARE) must be added. Text is placed outside the symbol in the lower right.

Do not show thermal or temperature measuring elements (TE) with a symbol or tag unless the loop association is not readily apparent (e.g., dual elements).

Show process connection purge and blowback requirements for all measuring devices requiring it. Include purge media and pressure. Show detailed hardware associated with purge/blowback (e.g., Rotameters) on installation details, auxiliary P&IDs, or cover sheets.

Air supplies to individual devices are not generally shown. Show air supplies to solenoids or other special applications as needed to clarify valve porting or operation (e.g., trip solenoids or pneumatic hand switches).

Show analyser sample points and connections.

The sampling system (when applicable) shall be appropriately depicted on the P&ID

Show a single stream analyser on the same P&ID as its sample point.

Show multi-stream analysers only once with off-page connectors from/to the multiple sample points/returns. Show sample connections that supply/return samples to/from multiple analyzers only once, with continuations to/from other analyzers. Show measured components at the upper left of each analyser or sample point bubble as required.

If an indicator is integral to a transmitter, then use a single bubble and tag (e.g., LIT). If separate devices are used for the transmitter and the indicator (e.g., a remotely located indicator), then show separate bubbles and tags (e.g., LT and LI).

Show level and gauge glasses with the appropriate symbol and tag. Use a single function (one bubble and tag) regardless of the number of individual sections required to span the length. A text label or note can be used to define the number of sections. Show separate bubbles and tags for redundant glasses or those for applications with separate taps (e.g., overlapping gauges).

Do not show the distance between level connections.

SAFETY/RELIEF DEVICES

The specific configuration requirements with respect to safety relief devices indicated on P&ID’s is as follows:

Show and tag relief devices and conservation vents (e.g., PSE and PSV).

Use optional explanatory text for clarification of the type and function of the device (e.g., “Emergency Relief,” “Conservation Vent,” “Explosion Panel”) located next to the tag. PSV typically refers to reclosing devices. PSE typically refers to non-reclosing devices. Use PSE only for safety related service. Use PCV or PCE for non-safety conservation vents.

INTERLOCKS AND ALARMS

Interlocks and alarms need not be shown on P&ID’s

EQUIPMENT AND INSTRUMENTATION TAGGING

Where no Employer directed Equipment and instrumentation tagging convention is provided, the following shall be adhere to as a minimum:

Area codes:

The following area coding convention shall be used throughout the site:

Example:

F	**A**	**A**

FAA where

F is the plant description
A is the area location
A (third letter) denotes the stream description

A complete list of area codes shall be developed for the project.

Equipment numbering convention:

The following numbering convention shall be used:

Example:

FAA	**-**	**PMP**	**-**	**001**

TGA-PMP-001 where

FAA is the area code
PMP is the equipment Identification code
01 is a sequential number

A complete list of equipment codes shall be developed for the project.

Line numbering convention:

The following line numbering convention shall be used on all P&ID drawings:

Example:

2 **5**	**-**	**P** **W**	**-**	**C** **S**	**-**	**00** **1**

25-PW-CS-001 where
25 is the nominal pipe size
PW is the product code
CS is the pipe material code
001 is a sequential number

A complete list of pipe product and material codes shall be developed for the project.

Mechanical valve numbering convention:

The following numbering convention shall be used:

Example:

FAA	**-**	**HV**	**-**	**001**

FAA-HV-001 where

FAA is the area code
HV is the valve code
001 is a sequential number

A complete list of valve codes shall be developed for the project.

Instrument Tag numbering convention:

The instrumentation tag numbering convention used in this specification is based on the ISA 5.1 standard and also uses the mechanical equipment number that the instrument is attached to.

Example:

F AA	**-**	**P MP**	**-**	**L SL**	**-**	**0 01**	

AAA-PMP-LSL-001A where

FAA is the area identification code
PMP is the mechanical equipment number
LSL is instrument identification letter as defined by the ISA standard
001 is a sequential number
A, B, C, D denotes the number of similar instruments within the same loop

Electrical Equipment Tag numbering convention:

The following electrical equipment tag numbering convention shall be used.

Example:

F AA		**P MP**		**M CC**		**0 01**	

AAA-LSL-8301A where

FAA is the area identification code
PMP is the mechanical equipment number
MCC is electrical identification code letter
001 is a sequential number
A, B, C, D denotes the number of similar electrical equipment within the same loop

Motor Control Equipment and I/O Tagging Convention:

The following shall be used in conjunction with the motor control equipment number for the identification of motor control equipment on P&ID's:

Motor Controlled Equipment	
MCD	Motor Control Drive (DOL)
MCV	Variable Speed Drive
MCS	Soft Starter

The following shall be used in conjunction with the motor control equipment number for the identification of motor control I/O:

Digital Inputs	
A	Healthy
B	Running

C	Remote/Local
D	Tripped
E	Fault
Digital Outputs	
F	Start
G	Stop
H	Reset
Analog Inputs	
I	Speed Feedback
Analog Outputs	
J	Speed Reference
Information Tags	
K	Number of Starts
L	Operating Hours

<u>Instrument LOOP numbering convention</u>

The following instrument loop numbering convention shall be used:

Example:

TGA	**-**	**D**	**-**	**PMP**	**001**

TGA-D-00.80 where

TGA is the process area code
D is the first letter of the instrument function and
PMP001 is the mechanical equipment number that the instrument is associated with

Part C4: SITE INFORMATION

C4.1 GEOTECHNICAL INVESTIGATION

A geotechnical Investigation was conducted for the Structures and Pipelines, see **Appendix G**.

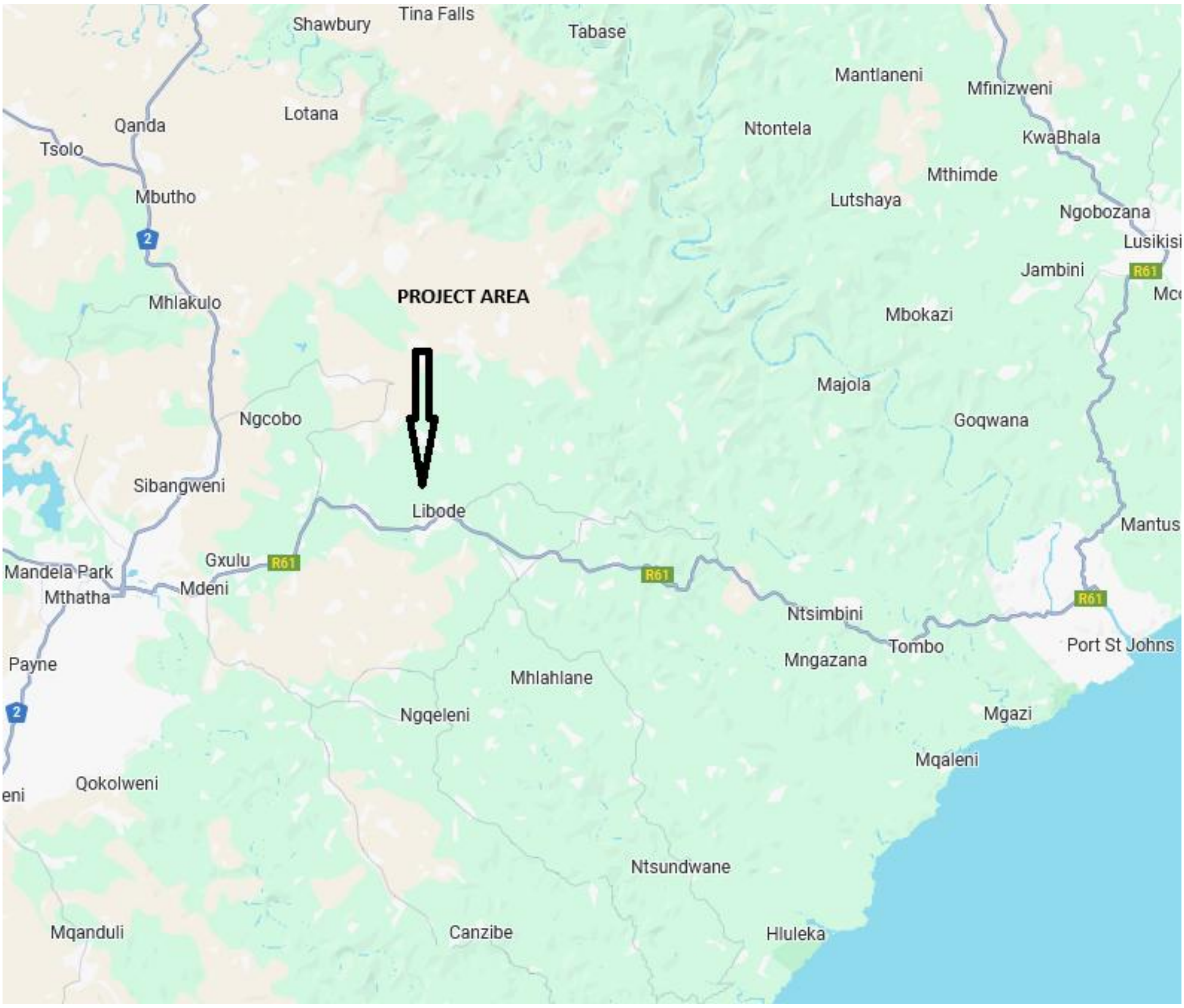
C4.2 RAINFALL DATA

Mthatha Rainfall Data between 2000 to 2020 was used for the on this project due to Coffee Bay weather station being more off than on. For Rainfall Data see **Appendix H**.

Part C5: TENDER DRAWINGS

REFER TO VOLUME 3

APPENDIX A: LOCALITY PLAN



APPENDIX B: MONTHLY REPORTING TEMPLATES

LABOUR MONTHLY SUMMARY SHEET

Name of Contractor
Project Name
Project Number
Applicable Month

No of Working Days: Maximum including training = 23 days per month

Number of workers	Surname	Initials	First Name	ID Number	Birth Date	(M)ale / (F)emale	(D)isabled	Rate per day	Number of days worked this month	Number of training days this month	Total amount paid to beneficiary	Course name	Course Code
1											0		
2											0		
3											0		
4											0		
5											0		
6											0		
7											0		
8											0		
9											0		
10											0		
11											0		
12											0		
13											0		
14											0		
15											0		
16											0		
17											0		
18											0		
19													
20											0		
											0		
20				Totals for month					0	0	0		

Signature Consultant

PAYMENT REGISTER

Contractor Name
Period
Project Number
Month:

Name and surname	ID Number	Contact no	Number of Workdays	Task Rate	Payment Due	Signature for Payment Received	Comments

Signature of CLO

Signature of Contractor to verify accuracy

Signature of Consultant

Signature of Contractor for receipt of monies

DAILY SITE ATTENDANCE REGISTER

Name of Contractor
Project Name

Project Number
Month:

1 = At Work SL = Sick Leave A = Absent P = Public Holiday L = Leave 2 = Training SC = Site Closed

Validation: Cannot be more than 23 days per person per month.

	Surname	Initials	ID Number	Birth Date	Rate per day (R)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	**Total Work days**	**Total Training Days**	**Total work days & training days**
1																																					0	0	0
2																																					0	0	0
3																																					0	0	0
4																																					0	0	0
5																																					0	0	0
6																																					0	0	0
7																																					0	0	0
8																																					0	0	0
9																																					0	0	0
10																																					0	0	0
11																																					0	0	0
12																																					0	0	0
13																																					0	0	0
14																																					0	0	0
15																																					0	0	0
16																																					0	0	0
17																																					0	0	0
18																																					0	0	0
19																																					0	0	0
20																																					0	0	0
20	**TOTALS**																													**TOTALS**							0	0	0

Signature of CLO

Week 1 -2: Signature of Contractor Organisation

Week 3-4: Signature of Contractor Organisation

Week 1: Signature of Contractor

Week 2: Signature of Contractor

Week 3: Signature of Contractor

Week 4: Signature of Contractor

Validation:		
	Total work days	0
	Total training days	0
	Total work days + training days	0
	Variance	0
	Variance must be 0	

6. Actual EMPLOYMENT GENERATION

BENEFICIARY LIST

Name of Contractor
Project Name
Project Number
Month:

Youth = 35yrs and less

Number of workers	Surname	Initials	Name	ID Number	Date of Birth	Male/Female	Has Disability (Y?N)	Is Youth (Y/N)	Education Level*	Date Start	Contact Number
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											

Signature of CLO

5.1. Actual Number of persons employed

Occupational Category			Adult				Youth				Disabled			
			Women		Men		Female		Male		Female		Male	
	Persons	Person Days	Persons	Person Days	Persons	Person Days	Persons	Person Days	Persons	Person Days	Persons	Person Days	Persons	Person Days
Clerical														
Labourer														
Managerial														
Semi-skilled														
Skilled														
Supervisor														
Total														

Please note: - The definition of youth is any person under the age of 35 years. (18-35 Years)
- Each person may only be counted once. If a person falls into more than one category, disabled persons take preference, then youth, then adults.
- Must include all occupational categories (Clerical, Labourer, Managerial, Semi-skilled, Skilled and Supervisor).

5.2. Average daily wage per category
Please note that the totals are calculated averages for the number of records submitted per category.

Occupational Category	Category Average	Adult		Youth		Disabled	
		Women	Men	Female	Male	Female	Male
		Daily wage	Daily wage	Daily wage	Daily wage	Daily wage	Daily wage
Clerical							
Labourer							
Managerial							
Semi-skilled							
Skilled							
Supervisor							
Average of the Daily Wage							

6. TRAINING ACTIVITIES

6.1 Non-Accredited Training

Training Type	Totals		Adult				Youth				Disabled			
			Women		Men		Female		Male		Female		Male	
	Persons Trained	Training days	Persons	Days	Persons	Days	Persons	Days	Persons	Days	Persons	Days	Persons	Days
Administration														
Technical														
Lifeskills/ ISD														
Literacy & Numeracy														
Vocational Skills														
Business Skills														
Total Training														

6.3 Accredited Training

Training Type	Totals		Adult				Youth				Disabled			
			Women		Men		Female		Male		Female		Male	
	Persons Trained	Training days	Persons	Days	Persons	Days	Persons	Days	Persons	Days	Persons	Days	Persons	Days
Administration														
Technical														
Lifeskills/ ISD														
Literacy & Numeracy														
Vocational Skills														
Business Skills														
Total Training														

6.4 Categories of Accreditation

Training Type	**If Accredited**		
	NSB Number	**NQF Level**	**ETQA/ CETA**
Administration			
Technical			
Lifeskills / ISD			
Literacy &Numeracy			
Vocational Skills			
Business Skills			
Total Training			

Note:
NQF Level of Training
Level 1 – General Education and Training
Level 2,3,4 - Further Education and Training
Level 5 - Higher Education and Training

NSB Number:
NSB 01: Agriculture and Nature Conservation
NSB 02: Culture and Arts
NSB 03: Business, Commerce and Management Studies
NSB 04: Communication Studies and Language
NSB 05: Education, Training and Development
NSB 06: Manufacturing, Employer’s Agenting and Technology
NSB 07: Human and Social Studies
NSB 08: Law, Military Science and Security
NSB 09: Health Science and Social Services
NSB 10: Physical, Mathematical, Computer and Life Sciences
NSB 11: Services
NSB 12: Physical Planning and Construction

7. SMME'S USED SINCE THE START OF THE PROJECT:

Please remember to include all the SMME's that worked on the project since it started. Then add all the person days and all the funds paid to each SMME since the start of the project, and only record the latest total in the table.
For example, if a SMME completed all their work during the first reporting period, the name and details of that SMME must be added to every subsequent report.

SMME	Information about the SMME. (If it is a subsidiary: provide information for whole group and not for the SMME only)		Information about the work on the PROJECT			
Name of SMME	No. of permanent employees	Turnover previous 12 months	Total no. of person days to date	Amount paid to SMME to date. (Total)	Person days locally sourced: 0-25% 26-50% 51-75% 75-100%	Total value of work: SMME Involvement

7. BEE ORGANISATIONS USED SINCE THE START OF THE PROJECT:

Note that Black Economic Empowerment (BEE) Organisations are referred to in the table below as Affirmable Business Enterprises (ABE's).
The definition of an ABE is as per the Department of Public Works definition: ***A sole trader, partnership or legal entity which adheres to statutory labour practises, is registered with South African revenue Services and is a continuing and independent enterprise for profit, providing a commercially useful function and for which at least two thirds (67%) is owned by one or more PDI's and whose management and daily business operations are in control of one or more PDI's who effectively own it, and provided that the annual average turnover excluding VAT, does not exceed the maximum values given for each respective ABE category.***

Please remember to include all the ABE's that worked on the project since it started. Then add all the person days and all the funds paid to each ABE since the start of the project, and only record the latest

ABE	Information about the ABE. (If it is a subsidiary: provide information for whole group and not for the ABE only)		Information about the work on the PROJECT			
Name of ABE	No. of permanent employees	Turnover previous 12 months	Total no. of person days to date	Amount paid to ABE to date. (Total)	Person days locally sourced: 0-25% 26-50% 51-75% 75-100%	Total value of work: SMME Involvement

APPENDIX C: PEM ENVIRONMENTAL SPECS

APPENDIX D: PHS OHS SPECIFICATION

APPENDIX E: HIV/AIDS AWARENESS EDUCATION SPECIFICATION

APPENDIX F: BASELINE RISK ASSESSMENT

APPENDIX G: GEOTECHNICAL INVESTIGATION

APPENDIX H: RAINFALL DATA