Johannesburg Water SOC Ltd

CONSTRUCTION OF 20ML CARLSWALD RESERVOIR

VOLUME 2A

PART 3: SCOPE OF WORK

Employer:		**Contractor:**	
Witness:		**Witness:**	

C3: SCOPE OF WORK

Portion 1: Project Specifications

PS 1 DESCRIPTION OF THE WORKS

PS 1.1 Employer's Objectives

The Employer's objective is to provide a new 20ML reservoir to augment the supply system for Johannesburg Water's current and future supply requirements in the Carlswald area. Currently, the region, which is zoned as predominately agricultural holdings, does not have enough capacity to allow the proposed developments in the area.

PS 1.2 Overview of the Works

The project involves the construction of a new 20ML domed roof, concrete reservoir and ancillary structures. These works will comprise Civil, Structural, Mechanical and Electrical Engineering elements.

PS 1.3 Extent of the Works

The above works include the following:

- Construction of new 20Mℓ domed roof, reinforced concrete reservoir.
- Construction of a scour chamber & 12 concrete leak detection chambers.
- Installation of all scour, overflow, drainage & leak detection pipework from the reservoir to the scour box.
- Installation of a stormwater pipeline from the scour box to the existing stormwater network.
- Construction of a new building which will house all the inlet & outlet valves, as well as the main bypass lines. This will include all the necessary control systems.
- Construction of a new telemetry building.
- Construction of a new guard house, including a new potable water & sewer line.
- Installation of a power supply to the new valve building, telemetry hut & guard house as well as installation of a standby generator and lightning protection.

- Installation of instrumentation cabling between the valve building and the telemetry hut and all required control and instrumentation to communicate with the JW.

- Installation of a security fence, site surveillance and a motorised gate.

PS 1.4 Location of the Works

The Works are located on Walton Road in Carlswald, Midrand, Gauteng Province. Refer to the locality plan included in Volume 2 of this Contract Document.

PS 1.5 Temporary Works

No temporary works are envisaged under this contract. No equipment intended for permanent installation shall be operated for temporary purpose without the written consent of, and in complete agreement with stipulations as set forth by the Employer's Agent.

PS 2 ENGINEERING

PS 2.1 Employer's Design

When and where specific reference is made or preference given to specified equipment, should the Contractor fail to comply with these requirements, this may lead to the disqualification of the tender submitted.

Contractors are free to propose alternative equipment (provided a main offer is submitted to specification) to that proposed by the Employer's Agent and, provided that drawings with details of each alternative proposal are submitted with the Tender, such alternative proposals will be considered in the adjudication of each Tender.

Any alternative equipment offered shall include all the necessary civil, mechanical, electrical and instrumentation costs necessary for a complete working system.

The cost of any changes to the Engineer's design will be for the Contractor's account where full details of the changes were not submitted with the tender.

Contractors shall satisfy themselves that the layouts as proposed by the Employer's Agent suit in all respects the equipment proposed by the Employer's Agent or by the

Contractor as the case may be. Where equipment other than that proposed by the Employer's Agent is accepted, it will be the sole responsibility of the Contractor to ensure that the associated equipment including pipe work is compatible with the accepted material and proposed structures.

In the case of the Employer's Agent's acceptance of an alternative proposal, the Contractor shall submit in triplicate to the Employer's Agent for his approval, detailed working drawings of the Contractor's alternative design proposal before any related work is executed.

An extension of Time for Completion of the Contract due to time spent on the alteration of the tender drawings to suit the Contractor's alternative proposals or, due to time spent in obtaining the Employer's Agent's approval of such alternatives, shall not be considered.

Acceptance of an alternative proposal or offer shall not relieve the Contractor of any of his obligations in terms of the Contract. The Contractor's cost of preparation and submission of an alternative proposal shall be deemed to be included in the rates tendered for the execution of the Work.

PS 2.2 Drawings

PS 2.2.1 Tender Drawings in Volume 4

With reference to PS 2.1 above, the drawings submitted will comprise a component of the Employer's proposed design. Drawings shall be read and understood in sufficient detail to understand the scope of the works required to be performed. If there are areas that appear unclear or if the Contractor deems there to be material errors in the design, he shall bring it to the immediate attention of the employer prior to the close of tenders. The Contractor is expected to address by letter any clarifications he may require in understanding the tender document and drawings, such that he may sufficiently price the document to complete all of the specified works.

The drawings, forming part of this Tender, are bound into Volume 4 of this document and are listed below. All tender Drawings must be returned at the time of tendering

together with the tender documents. If the Contractor deems there to be drawings missing, he shall inform the Employer immediately for clarification.

The drawings included in these tender documents are intended for tender purposes only and shall not be used for construction purposes.

Only working Drawings which have been approved by the Employer's Agent and marked accordingly as follows: "This Drawing approved for construction by": and which have been signed and dated by him and officially issued to the Contractor for construction, shall be used on the Works.

The drawings that are issued for tender purposes are listed below:

CIVIL ENGINEERING DRAWINGS

SECTION 01 - GENERAL ARRANGEMENT	
13214-73-01-001	Layout of Proposed Reservoir
13214-73-01-002	Structure and Fence Setting Out
SECTION 02 -TERRACING, STORMWATER & FENCING	
13214-73-02-001	Layout & Setting Out of Pipework
13214-73-02-002	Leak Detection & Scour Piping Long sections
13214-73-02-003	Inlet & Outlet Piping Long sections
13214-73-02-301	Fence Layout & Details
SECTION 03 - SITE SERVICES	
13214-73-03-001	Proposed Sewer Network Layout
SECTION 04 - RESERVOIR	
13214-73-04-001	General Arrangement & Details
13214-73-04-002	Leak Detection, Cat ladders & Access Hatch Details
13214-73-04-003	Piping Details
13214-73-04-004	Flowmeter Chambers – 3D Views
13214-73-04-005	Flowmeter Chambers - Layout, Sections & Details
13214-73-04-006	Valve Chamber – 3D Views
13214-73-04-007	Valve Chamber - Layout, Sections & Details
13214-73-04-010	Scour Box- 3D Views
13214-73-04-011	Scour Box - Layout & Sections
13214-73-04-012	Interconnecting Piping Layout
13214-73-04-013	Pipe And Valve Schedule
SECTION 05 - BUILDINGS	
13214-73-05-001	Telemetry Building Layouts, Elevations, Sections and Details
13214-73-05-002	Guard House 3D Views
13214-73-05-003	Guard House Layouts, Elevations, Sections And Details
13214-73-05-004	Valve Building – 3D Views
13214-73-05-005	Valve Building - Layout & Elevations

13214-73-05-006	Valve Building - Sections & Details

ELECTRICAL DRAWINGS

SECTION 06 – ELECTRICAL	
13214-73-06-001	Electrical Cable Route
13214-73-06-002	Earthing Layout
13214-73-06-003	Single Line Diagram
13214-73-06-004	Typical Loop Diagram Level Sensor
13214-73-06-005	Typical Loop Diagram Magnetic Flow Meter
13214-73-06-006	Typical Loop Diagram Open/Close Actuator
13214-73-06-007	Typical Loop Diagram Modulating Actuator
13214-73-06-008	Guard Hut Power and Lighting Layout
13214-73-06-009	Telemetry Hut
13214-73-06-010	Typical Field JB's
13214-73-06-011	Typical Field PLC
13214-73-06-012	Earthing and Lightning Symbols
13214-73-06-013	Exterior Lighting Layout
13214-73-06-014	Valve Building Power & Lighting Layout

PS 2.2.2 Construction Drawings

Upon receiving the instruction to commence with construction, the Contractor shall receive 3 sets of construction drawings, of which 1 set shall be designated for as-built records and updated by the Contractor on a daily basis. The drawings shall be submitted to the Employer's Agent with the Contractor's request for issue of the Practical Completion Certificate.

PS 2.2.3 Shop Drawings

Where an item to be supplied in conformance with this Contract Specification has not been designed by the Employer's Agent or Employer, the Contractor shall be required to supply the Employer's Agent with 3 copies of detailed shop drawings prior to delivery of materials, including an electronic copy in drawing format that

is compatible with the software packages (AutoCAD or .dxf) used by the Employer's Agent and/or Employer. Only on approval of such shop drawings or an amended version thereof, shall the Contractor proceed with the manufacturing, supply and installation of the designed item.

PS 3 PROCUREMENT

PS 3.1 Preferential Procurement Procedures

The Contractor's attention is drawn to the following returnable schedules contained in Part T2:

a. Empowerment and Preferential Procurement (JW10); and
b. Enterprise Declaration Affidavit (to be endorsed by a Commissioner of Oaths) (JW11).

These schedules contain all requirements about preferential procurement.

PS 3.2 Sub-Contracting

PS 3.2.1 Definitions

a. Start-up Enterprises

An enterprise that has been in existence and operating for less than two years.

b. Small Enterprises

An enterprise that has a CIDB grading designation of 1 or 2.

c. Micro Enterprises

An enterprise that has a CIDB grading designation of 3.

d. Locally based SMMEs

Enterprises that have their operational base in the ward in which the project is to be executed or, alternatively, the members of the enterprise are resident in the particular ward. Should a suitable locally based SMME as defined above not be available in the particular ward, then they shall be sourced from adjacent wards.

a. Contract Participation

Contract Participation in terms of this contract is a process by which the Employer implements Government's objectives by setting a target relating to small Contractor development which the Contractor shall achieve as a minimum.

b. Contract Participation Goal (CPG)

Contract Participation Goal is the monetary value of the target set by the Employer in the Contract Participation process.

c. Contract Participation Performance (CPP)

Contract Participation Performance is the measure of the Contractor's progress in achieving the CPG.

The commitment of the Employer to Government Policy concerning the empowerment of the SMMEs shall be noted and adhered to by the Contractor. It is against this background that Johannesburg Water has made provisions under this contract to ensure that the Contractor impart skills to the SMME within the project area during the project implementation.

The onus is upon the Contractor to handle and manage the procurement process of the Sub-Contractors and once appointed, should be dealt with in accordance with the provisions of Clause 4.4 of the General Conditions of Contract 2015.

The Contractor shall not cede or assign the Contract or any part thereof without the prior written approval of the Employer's Agent.

The Contractor shall obtain the written approval of the Employer's Agent before appointing any Sub-Contractor. The Contractor shall be solely responsible for the supervision of and payments to such a Sub-Contractor(s) and the approval of a Sub-Contractor by the Employer's Agent shall not indemnify the Contractor from any of his liabilities in terms of the Contract.

Approval given in terms of subcontracting shall not relieve the Contractor of any responsibility, duty or obligation imposed upon him by the Contract, and the Contractor shall in particular be and remain solely liable and responsible for all acts,

omissions, negligence or breaches of contract on the part of the assignee or any of his employees, and for all acts, omissions or negligence of any sub-Contractor or any of his employees.

PS 3.2.2 Applicable Legislation

The following Acts, as amended from time to time, are predominant amongst those which apply to the construction industry and are listed here for reference purposes only:

- The Constitution of South Africa.
- Preferential Procurement Policy Framework Act No. 5 of 2000.
- Construction Industry Development Board Act No. 38 of 2000.
- Broad-Based Black Economic Empowerment Act No. 53 of 2003.

PS 3.2.3 Scope

The City of Johannesburg has identified job creation and access to procurement opportunities by Start-ups, Small and Micro enterprises (SMMEs) as an essential requirement towards building an economically viable City.

This tender is subject to the sub-contracting conditions as described in the Contract Data, and must be adhered to by the main contractor.

NB: all sub-contractors appointed on this contract must comply with the Central Supplier Database (CSD) requirements, i.e. they must be registered on the CSD.

It is a condition of this contract that the Contractor is required to sub-contract a minimum value of work to SMME equal to 30% of the Contract Sum.

The Contractor is to allow for fortnightly certificates from the SMMEs and for payment to the SMMEs to be effected within 7 days of certification. To achieve the goals of this policy and to ensure that the SMMEs are treated fairly and given every opportunity to advance their business whilst delivering a successful project, the

Contractor is to note the following and provide for any cost that may be associated therewith:

a. The Contractor will be expected to have clearly specified the programme dates to the SMME and these dates are to be included in the contractual agreement between the two parties. The Contractor is to monitor the SMME's progress against the programme and hold progress meetings with the SMME contractors where minutes are to be kept and signed off by both parties.

b. Before site establishment, the Contractor will provide each appointment letter and contractual agreement that the Contractor engages with for each SMME on this Project. The Agreement must include agreed work values agreed upon with the Contractor and SMME.

c. Before site establishment, the Contractor will provide the following for all SMMEs:

   - SMME company registration
   - SMME CIDB proof of registration.

d. The Contractor is to assess the skills of the SMME and provide the relevant support and training for the SMME to complete the works to programme, budget and specification. The Contractor will be expected to provide training to the SMME that will ensure that the SMME's staff is suitably trained to execute the works and that they receive sufficient relevant experience on the project.

e. The Contractor is responsible for safety compliance on the project and will assist the SMME Contractors in all aspects to achieve safety compliance, that will include:

   - Assisting the SMME with developing their safety files, legal appointments, etc.
   - Assisting the SMME with achieving safety on site.

- Having toolbox talks with the SMME Contractor's employees on a daily basis.
- Providing all safety equipment and signage.
- Providing safety training where necessary.

f. The Contractor is to provide all the necessary equipment for the timeous monitoring and the checking of the quality of works as carried out by the SMME. The Contractor will be expected to monitor the SMME's works for quality compliance and provide all the necessary support to the SMME in order to achieve quality requirements. The Contractor is to ensure that if the SMME's quality of works does not achieve specification, the Contractor will assist the SMME to achieve specification and not allow the works to continue until the quality requirements are achieved.

g. The Contractor is to generate monthly reports for the Johannesburg Water SOC. which includes the following:

- Per SMME: resources on the site, i.e. supervisors, labour, plant tools and equipment
- Per SMME: progress of works on site.
- Per SMME: quality control on site.
- SMME expenditure on the project versus target expenditure including payment progress
- Copies of minutes of the SMME and Contractor progress meetings.
- Concerns and improvements to be made.
- Items listed in PS 5.10

h. In the execution of the Subcontract Work, the Contractor shall ensure that the Sub-Contractor(s) comply with all relevant legislation and regulations including, but not confined to, the Occupational Health and Safety Act. The Contractor hereby indemnifies the Employer against any loss, damage, or claim for Subcontract Works set out for the construction of the Carlswald Reservoir as well as the new pump station arising out of the former's failure to comply with instructions issued to him in regard to these requirements.

i. The Contractor shall be required to adopt labour intensive construction techniques through the allocated work in the Bill of Quantities, with the proviso that the Employer's specific objectives regarding time and quality are not compromised. Maximisation of employment shall be the aim on this contract.

j. Together with their tenders, all Contractors are required to submit a comprehensive implementation plan clearly stating the labour content and number of jobs that shall be created. The employment of labour shall be reflected in a programme in sufficient details to enable the Project Manager to monitor and compare it with the implementation plan.

k. The Contractor shall be required to submit employment data on a monthly basis to the Employer's Agent.

l. Contractors are to also note that it is an explicit condition of this Contract that all unskilled labourers on the project are to be employed from the local community. The Contractor shall, in general, maximise the involvement of the local community.

m. TRAINING OF SMMEs: The sum shall be in full compensation for the provision of training to SMMEs, to complete the works as per specifications

Unit: Sum

PS 3.2.4 Supply & Delivery of Equipment

A delivery period of 14 weeks, within which all materials and equipment must be delivered to site, is envisaged. If the Tenderer considers the delivery time of 14 weeks inadequate for particular items, he must specify the delivery period required for each item in the covering letter to the Tender Document.

The term "supply and deliver" of materials and equipment includes the purchase thereof from commercial sources, manufacturing thereof, factory corrosion protection, factory testing, provision of test certificates certifying compliance of the goods in accordance the Specifications, provision of drawings and details, provision of special tools and keys, the handling thereof and delivery to Site.

Tender rates must provide for all the costs by the Contractor to "supply and deliver".

No other payment for materials and equipment will be considered other than that under the "supply and deliver" items in the Schedule of Quantities.

PS 3.2.5 Purchasing of Equipment

The Contractor is required to purchase the materials and equipment necessary for the Contract at the earliest possible date thus limiting the effect of inflation. The Contractor must strive to keep the number of suppliers to a minimum.

Payment for materials and equipment will only be effected if the Contractor can prove ownership of the items.

In the case that off-site storage is agreed by the Employer's Agent and Johannesburg Water then payment will only be effected if the Contractor can prove ownership and that cession of ownership from the Contractor to Johannesburg Water has taken place.

NOTE - It will be the Contractor's responsibility to ensure that the necessary warranties from the equipment suppliers is negotiated such that it only comes into effect on commissioning of the equipment.

PS 3.2.6 Guarantee of Equipment

It is an express condition of this Contract that the guarantee period on all equipment given by the suppliers to the Contractor shall only commence once the Works is in operation. This stage will be reached once the Certificate of Completion has been issued.

PS 3.2.7 Particulars of Equipment Offered

The Tenderer must include comprehensive information covering every item of equipment offered with his Tender. The Employer's Agent must be able to determine, without reference to the suppliers, any information regarding delivery, power consumption, efficiency, accuracy, etc. applicable under the specified range of operation conditions.

Technical information regarding equipment offered must also be supplied.

Failure to comply with the above requirement may lead to the disqualification of the Tender submitted.

PS 3.2.8 Bill of Quantities

The prices quoted in the Bill of Quantities shall cover the cost of all work required for the execution of the Contract and each price shall be considered as the full value of the work described in each item and as covering all contingent expenses.

PS 3.2.9 Bonds & Guarantees

Security in the amount equal to ten (10) per cent of the contract price shall be provided by the Contractor for the due and faithful performance by him of all the duties and obligations resting upon and assumed by him in terms of the Contract.

Such security shall be in the form of a deed through lodging a bond of suretyship furnished by an approved bank, insurance or guarantee corporation in such form as may be prescribed by Johannesburg Water, provided however that the Employer's Agent may, upon written application by the Contractor, return to the Contractor the whole or part of such security held by Johannesburg Water. The Employer's Agent will, subject to his sole discretion, consider what he deems sufficient for the protection of Johannesburg Water, and is entitled to hold all or a portion of the security until the completion of the Contract and the expiry of the defects liability and Defects Liability Period.

PS 4 COMPLETION OF THE WORKS

The Time for Completion as stated in the Contract Data is 15 months If the Contractor considers the completion time of 15 months inadequate, he must specify the completion period required in his covering letter to his Tender.

PS 5 CONSTRUCTION

PS 5.1 APPLICABLE STANDARDS

PS 5.1.1 National Standards (Civil)

The Standardised Specifications for all associated civil work applicable to this Contract shall be:

Civil Works	
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 DM	Earthworks (roads, subgrade)
SANS 1200 G	Concrete (Structural)
SANS 1200 GA	Concrete (Small Works)
SANS 1200 H	Structural steel work
SANS 1200 HA	Structural Steelwork (Sundry Items)
SANS 1200 L	Medium Pressure Pipelines
SANS 1200 LB	Bedding (Pipes)
SANS 1200 LD	Sewers
SANS 1200 LE	Stormwater Drainage
SANS 1200 ME	Subbase
SANS 1200 MF	Stabilisation
SANS 1200 MJ	Segmented Paving
SANS 1200 MK	Kerbing and channelling
SANS 1200 MM	Ancillary Roadworks

PS 5.1.2 National Standards (Mechanical, Electrical and C&I)

The Standard Specifications for all associated electrical and instrumentation work applicable to this Contract shall be SANS 10142-1:2003.

These Specifications are not issued with this volume but are available at the Contractor's expense from: South African National Standards. The Contractor shall be in possession of these Technical Specifications and shall keep a hard copy of the specifications on site for reference by him and the Employer's Agent for the duration of the Contract.

Office Address:
1 Dr Lategan Road,
Groenkloof, Pretoria

Postal Address:
Private Bag X191,
Pretoria, 0001

Telephone:
National: (012) 428-6883
International: + 27 12 428 6883

Telefax:
National: + 2712 428-6928
International: + 27 12 428 6928

Email: sales@sabs.co.za

PS 5.1.3 Other Standards

Other Standard Specifications applicable water tank design, to this Contract shall be:

a. BS8007:1987 Code of Practice for Water Retaining Structures

b. BS5337:1976 Code of Practice for Water Retaining Structures

c. BS8110:1997 Code of Practice for Reinforced Concrete design

PS 5.1.4 Particular Generic Specifications

Civil

Refer to Portion 2: Variations and Additions to the Standardized Specifications.

Mechanical

Refer to Portion 3: Particular Specifications of Volume 3.

Mechanical Works	
M20	Mechanical Valves – Manufacture and Supply
M21	Mechanical Pressure Pipework

Electrical and C&I

The following Particular Generic Specifications (refer to Portion 3) forming part of the Contract have been written to cover phases or items of work involving a specialist type of operations or material to be encountered on this Contract and that are not adequately covered by the general specifications.

Electrical Works (Automation and Control Design Standards)	
Volume 3	PLC Panels
Volume 5	Clean Power and Surge Protection
Volume 6	Cabling
Volume 7	Networking
Volume 8	Flow Measurement
Volume 9	Level Measurement
Volume 19	Field Junction Boxes and Panels

Electrical Works	
E01	Electrical Motors
E02	Electrical Cable Racks
E04	Electrical Low Voltage Switchboards and Motor Control Centres
E07	Electrical Industrial Plugs, couplers and socket outlets
E08	Electrical Wiring
E09	Building Installations
E11	Earthing and Lightning Protection

Painting Specification	
G01	Colour Coding of Equipment
G02	Corrosion Protection

PS 5.2 Plant & Materials

All materials intended for the purpose of this Contract shall bear the approval of the relevant SANS specifications. Any deviations there from shall be recorded and reported by the Contractor for approval by the Employer's Agent.

Johannesburg Water shall have the right to refuse acceptance of any material or workmanship which is found to be unsound, damaged or contrary to the specification, or which is found during the Defects Liability Period or during tests in situ to be defective or in any way contrary to the specification due to causes within the Contractor's control or responsibility. All material or construction rejected by the Employer's Agent shall be replaced or repaired by the Contractor at his own expense to the satisfaction of the Employer's Agent, whose decision with regard to this matter shall be binding on the Contractor.

All materials used shall be the best of their respective kinds and shall be suitable for working at the pressures and temperatures involved under all working conditions, without distortion or deterioration or the setting up of undue stresses in any part and without impairing the efficiency or reliability of the plant and the strength of its

component parts. No welding, burning, filling or plugging of defective castings will be permitted without the Employer's Agent's approval in writing.

Materials to be supplied "Free Issue" to the Contractor will be indicated as such in the Bill of Quantities.

PS 5.3 Construction Equipment

In addition to GCC (2015) Clause 7, no plant will be supplied by the Employer, however the Employer does reserve the opportunity to negotiate with the Contractor that different plant be used of another origin for whatever purpose that may become apparent at the time.

In so doing the Contractor shall supply and use suitable and sufficient construction plant, tools, equipment and material as may be required to carry out the Works efficiently. Only the construction plant, tools, equipment and material which are required for this purpose shall be brought onto the Site and shall be stored, stacked or erected in such a way as not to interfere with other work or traffic. The Contractor shall furnish statements showing details of construction plant, tools, equipment and material employed or used on the Works on a day to day basis, the Daily Site Diary indicating types, numbers, quantities, hours worked, idle time, etc. all as stipulated in the Project Specification or as directed by the Employer's Agent.

Construction equipment shall be suited for the onsite intended use and shall conform to all relevant safety aspects required by the OHS Act Purchasing of Equipment.

PS 5.4 Existing Services

The Contractor shall make himself acquainted with all existing works. Under no circumstances shall the Contractor alter or in any way interfere with existing works or underground services unless authorised by the Employer's Agent.

Where existing works are of such a nature that the Employer's Agent may require them to be moved by the Contractor, the cost of such work will be paid for at scheduled rates or on dayworks, plant and materials basis. The Contractor will be

held responsible for damages to any existing works and any damages caused shall be made good at his own cost without delay.

The Contractor is to exercise care when the proposed work is to cross an existing service, or work is to be performed close to an existing service. Prior to commencement of the relevant portion of the proposed works the Contractor with the Employer's Agent or his duly appointed representative shall also perform a visual inspection of the area in question. This inspection will not waive the Contractor of his obligations with respect care of the works referenced in GCC (2015), Clause 8.2.

PS 5.4.1 Service Providers

Organizations, which have special conditions for crossing of services, are:

a. Johannesburg Water
b. Eskom
c. Telkom
d. Fibre Providers
e. Johannesburg Roads Agency

For crossing or working in close vicinity of a service under the control of any of the above organisations, the organisation shall be notified and its general and specific requirements for each crossing or operation shall be carefully observed.

PS 5.4.2 Priorities

Services are labelled Priority 1 (P1), Priority 2 (P2) or Priority 3 (P3) on construction Drawings according to the procedure to be observed.

Priority 1. Indicates an extremely important service.

Priority 2. Indicates a less important main service.

Priority 3. Indicates minor services and leadings

PS 5.4.3 Procedures

Procedure for Priority 1 Services

These services are extremely important.

Once the Contractor is appointed for the Contract, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the Drawings with details of each of the services from the service providers.

The Contractor shall then arrange a meeting with the service provider and the Employer's Agent, to discuss the proposed work. Immediately after the meeting, the Contractor shall confirm in writing the content of this meeting.

At least seven days prior to the anticipated service crossing, the Contractor shall request the service provider to either expose the service or to supervise the exposure of the service. The service provider will nominate a representative, who will remain on site for the duration of all works in the vicinity of the service. No work whatsoever closer than 1,5 meters from the outer extremities of the service shall be carried out in the absence of this service representative. This representative shall have full authority to protect the safety of the service being crossed, including the power to halt and revise the Contractors work methods should he feel his service is in danger of being damaged.

Backfilling around and above the service will either be done by the service provider or under his supervision to the contract specification.

All instructions shall be in writing, acknowledged by signature of the party receiving the instruction. On completion of the work at a service crossing, the service provider will confirm in writing that his service is undamaged.

Procedure for Priority 2 Services

These are less important main services.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers.

Prior to working close to a service marked P2, the Contractor must discuss the service crossing with the Employer's Agent.

It is the responsibility of the Contractor to locate the existing service before the anticipated crossing by hand excavation. Excavation must be done by shovel only. If this is impossible, work must be discontinued and the problem reported to the Employer's Agent for further instructions. Any damage, however small, must be reported immediately.

On exposing the services, the Contractor must notify the Employer's Agent that such service has been exposed and must arrange for a site visit by the Employer's Agent to inspect the service for any possible damage. When services have been located, no machine excavation may be done within one metre on either side of such service.

In the event of the indicated service not being located, the Contractor shall inform the Employer's Agent, who will in turn request the service provider for assistance.

Backfilling may only be carried out in the presence of the representative of the service owner who will provide a written clearance indicating that the work has been completed without damage to the original service.

Procedure for Priority 3 Services

These are minor services.

It is seldom possible to indicate the position of these minor services and leadings on a drawing and the initiative of the Contractor is relied upon to locate it.

Exposure of these services is the responsibility of the Contractor, and must be done with caution, by hand. Any damage shall be reported to the Employer's Agent

immediately. No machine excavation is to take place within one meter on either side of the exposed service.

Before backfilling is done, the service shall be inspected by the Employer's Agent's Representative who will give the service provider the option of inspecting his service.

PS 5.4.4 Damage to Existing Services

In addition to GCC (2015), Clause 8.2, should an existing service be damaged, the procedure as set out below is to be followed. The Contractor must:

1. Take immediate steps to minimize:
    - Damage and loss to property of the service provider and the public e.g. arrange to close down valves, shut off pumps etc.
    - Inconvenience to the public.
    - Further damage to the already damaged service.
    - Damage to other services.
2. Ascertain if an important service is in the vicinity of the problem by carrying out the following checks on available drawings:
    - Eskom power line.
    - Johannesburg Water potable water lines
    - Johannesburg Road Agency stormwater lines
    - Fibre Providers

If any of the above are present, the Employer's Agent must be informed.

3. The Contractor must contact the Works Manager and inform him/her of the problem.

4. The Contractor shall then contact the relevant organisation and arrange for site or other suitable representation by the organisation whose service may be affected. Failing co-operation, he should refer the matter to the Employer's Agent, who must repeat the request for co-operation and record the reaction.

5. The Contractor shall not allow any machine excavation at the site of the problem unless:

- No other services are in the vicinity.
- All affected organizations are represented on site.
- Any organization not represented has given written permission for machine excavation.
- All other services are made visible and adequately protected.

6. The machine shall not work closer than one metre from any undamaged service.

7. All excavation work shall preferably be done by hand using shovels only.

8. On completion of repair work, all representatives of other organizations must be requested to inspect their respective services and give written confirmation that their service is undamaged before backfilling takes place.

PS 5.4.5 Procedures When Dealing with Existing Electrical Services

The following procedures are to be followed when a proposed service is to cross an existing electrical service or work is to be performed in close proximity to an existing service.

Procedure for P1 Service

These are highly important services.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers.

The Contractor shall then arrange a meeting with the service provider and the Employer's Agent to discuss the proposed work. Immediately after the meeting, the Contractor shall confirm in writing the content of this meeting.

1. The Electrical Engineer must be informed in writing, a minimum of seven (7) working days before work commences at or near the site in question and work shall not commence until this has been acknowledged.

The following special conditions shall be complied with:

- No excavation work is done within three (3) metres of the centre line of the cable/s or any of its ancillary equipment, other than for the purpose of crossing the service.

- Should it be necessary to cross the cable/s at any point, no excavation work by means of earthmoving machinery may be done. The necessary material to support the cable or to protect it from any damage whatsoever shall be supplied free of charge or supplied by the Electrical Engineer and the costs recovered from, the Contractor. Should the Electrical Engineer decide that the Contractor may do the work it shall be under the constant supervision of the Electrical Engineer.

- The crossings are so designed as to ensure a minimum distance of one (1) metre between the cable/s and any object. If the said minimum distance cannot be maintained an approved reinforced type concrete culvert shall be installed over the service by the Works at the cost of the Contractor.

- The necessary liaison is arranged with the Electrical Engineer during installation of any object in order to ensure that the equipment of the Works is not damaged in any way.

- The crossing of the service is made only under the strict supervision of the Electrical Engineer.

- No blasting work is done in close proximity to the service and that all blasting work required is approved by the Electrical Engineer.

- Full details of the exact location of the service and its ancillary equipment, as well as any other information required must be obtained from the Electrical Engineer.

- The accompanying form acknowledging all of the above shall be signed.

2. During the duration of the operation the Works Manager will make certain that the service is protected and reserves the right to stop work should he feel that the work being performed could endanger the service. The matter will then be referred to the Electrical Engineer.

3. Should any damage be caused to the Works service the costs of repairs will be for the Contractor's account.

4. The Electrical Engineer will close and make good the excavations.

5. The written agreement mentioned above will be signed off by both parties.

6. The costs incurred in all of the above will be to the account of the Contractor.

7. Should the Cable Surface Right be affected the following additional procedures shall apply:

    - No excavation work, storage and parking of motor vehicle is done within two (2) metres of the cable or any of its ancillary equipment such as oil pressure tanks, joint bays and link boxes, other than for the purpose of crossing the cable.
    - Should it be necessary to cross the cable at any point, no excavation work by means of earthmoving machinery is done, proper cable supports to the satisfaction of the Electrical Engineer are installed and the crossings are so designed as to ensure a minimum distance of one (1) metre between the cable and any object. For this purpose it must be noted that the cable has been laid at an average depth of 1 m.
    - No crossing, structure, fence or any other object shall be constructed over any of the existing cable joints.

- Cable crossing be made only under the strict supervision of the Electrical Engineer.
- No blasting work is done in close proximity to the cable and that all blasting work required is approved by the Electrical Engineer.
- Access be provided at all times (24 hours a day 7 days a week) where the Employer's surface right permit is to be crossed during and after construction.
- No trees and/or shrubs may be removed or planted except by or with permission from the Employer's Agent.
- Where vehicular crossing is required such crossing shall conform to the requirements of the Electrical Engineer.
- Before work in the vicinity of the Employer's surface right commences the Electrical Engineer shall be informed and his permission obtained to proceed.

Procedure P2

These are services of secondary importance.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers. Prior to working close to a service marked P2, the Contractor must discuss the service crossing with the Employer's Agent.

1. The Electrical Engineer must be informed in writing two (2) working days before work commences and such work shall not commence until this has been acknowledged.

    - The top 300 mm of soil above the service may be removed by pick and shovel.
    - The remainder of the cover shall be removed carefully by shovel only. If any damage, however small, is caused to the cable it must be reported immediately. The costs of repairs will be for the Contractor's account.

- When the cable is exposed, the Electrical Engineer or his representative must be informed in order that it may be inspected. No machine excavation within a one-meter radius of the exposed cable is permitted.

2. When the work is completed the excavations may be backfilled until the cable is just exposed when the Electrical Engineer's representative shall inspect once again for possible damage.

   Backfilling will then proceed in the presence of the Electrical Engineer's representative who will provide a written clearance when the job is completed.

PS 5.5 Site Establishment, Facilities Available and Required

PS 5.5.1 Water Supply for Construction Purposes

The Contractor is responsible for sourcing and providing a constant supply of clean potable water for the duration of the Contract. All costs for the provision of water shall be priced in full under the relevant scheduled items.

PS 5.5.2 Power Supply for Construction Purposes

The Contractor is responsible for sourcing and providing electricity for the duration of the Contract. The Contractor shall ensure that electricity is available during periods of loadshedding. All costs for the provision of electricity shall be provided in full under the relevant scheduled items by the Contractor.

PS 5.5.3 Site Office, Store and Housing

The Contractor will be permitted to establish a stores yard and to erect presentable temporary buildings for the storage of materials and for offices and latrines, all of which shall be neatly fenced. The fence must be sturdy, as indicated on the drawings, and must be fitted with a lockable vehicle entrance gate and shall be at least 2 m in height.

The Contractor shall employ security staff to provide security services to his site camp and other storage areas. The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

No housing for the Contractor's employees on site is permitted under any circumstances. The Contractor shall make his own arrangements to house and transport contracting staff. On completion of the Works, or when ordered by the Employer's Agent, the Contractor shall remove all temporary buildings and latrines and restore the Site to a clean and sanitary condition to the satisfaction of the Employer's Agent. He shall rehabilitate the area in accordance with the EMP.

Upon completion of the work in terms of this Contract, the site must be cleared of all structures, concrete slabs and waste. The area is to be rehabilitated according to the Specification.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

PS 5.5.4 Crane and Lifting Equipment

Crane and lifting equipment is not available on the site.

PS 5.5.5 Telephone Facilities

The Contractor will be responsible for arranging his own telephone facilities and will be responsible for all costs relating thereto.

PS 5.5.6 Ablution Facilities

Ablution facilities are not available on site. The Contractor shall therefore make the necessary arrangement to provide these facilities. Chemical serviced toilets shall be the minimum acceptable standard as indicated in the Environmental Specifications. These must be placed in a position to be approved by the Employer's Agent. The facilities must be to the Employer's Agent's approval and must be maintained in a clean and sanitary condition.

PS 5.5.7 Storage Facilities

Storage are not available on site. The Contractor shall therefore make the necessary arrangement to provide these facilities. The facilities must be to the Employer's Agent's approval and must be maintained in a clean and sanitary condition.

The Contractor shall make his own arrangements to secure the facilities.

PS 5.6 Site Facilities Required

PS 5.6.1 Facilities for the Employer's Agent

Provision for a minimum sized office measuring 3 meters by 4 meters, designated for the utilisation of the Employer's Agent should be made. The office space is to be fully equipped with an air-conditioning system to ensure optimal working conditions. Additionally, a dedicated ablution facility intended exclusively for the use of the Employer's Agent must be included. A conservancy tank will be required to service this ablution facility, and will be required to be emptied on a regular basis by the Contractor. A BoQ item has been provided for this work.

PS 5.6.2 Name boards

Two name boards shall be erected and the boards shall comply with the format and size as directed by the Employer's Agent. The Name boards shall be erected within a month of the Letter of Award.

No other name board other than those stated above shall be allowed. The Contractor shall remove the boards from the Site of Works on completion of the Contract.

PS 5.6.3 Protective Clothing

The Contractor is not obligated to provide Personal Protective Equipment for the Employer's Agent.

PS 5.6.4 Facilities for the Contractor

The Contractor will be permitted to establish a stores yard and to erect presentable temporary buildings for the storage of materials and for offices and latrines, all of which shall be neatly fenced. The fence must be sturdy, covered with diamond mesh wire and fitted with a lockable vehicle entrance gate and shall be at least 2 m in height.

The Contractor shall make his own arrangements to secure the facilities provided.

The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

Upon completion of the work in terms of this Contract, the site must be cleared of all structures, concrete slabs and waste. The area is to be rehabilitated according to the Specification.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

PS 5.6.5 Waste Disposal Sites

The Contractor shall make his own arrangements for solid and liquid waste disposal. Disposal shall take place at an approved site.

PS 5.7 Site Usage

Access to the Site can be obtained via Walton Road or Whisken Avenue. No restriction on access to the Site of Works will be placed on persons or vehicles involved with the execution of the Works. All traffic on Site shall be restricted to the maximum speed of 40 km/h and vehicles must be driven by licensed drivers with extreme caution.

The Contractor shall be required to report daily to the Employer's Agent's personnel on the Works.

The Contractor's staff shall be identified by either clothing or an identification tag, which shall be displayed when entering the Site of Works.

Access is to be made available to Johannesburg Water's employees to any portion of the Site whenever required.

The Contractor shall be responsible for the closing of all gates on roads and tracks used by him or his employees.

PS 5.8 Permits and Wayleaves

All required permits & wayleaves must be obtained by the Contractor before work in affected areas may commence.

PS 5.9 Alterations, Additions, Extensions and Modifications to Existing Works

The existing operational JW bulk water pipeline located on Walton Road must remain operational for the duration of the contract and can only be taken out of operation for a maximum period of 4 hours. This will be done to enable the Contractor to tie the new inlet and outlet lines from the Carlswald Reservoir into existing pipeline. The number of interruptions in operation shall be limited to the minimum as far as possible.

PS 5.10 Water and Electricity for Construction Purposes

The responsibility lies with the Contractor to negotiate all costs and necessary connections that might be required during the execution of the works as set out in Clause PSA 4.2 of Portion 2. All connections will conform to the requirements of Johannesburg Water and costs applicable will be paid by the Contractor.

PS 5.11 Survey Control and Setting out of the Works

The Contractor shall be responsible for the construction of survey beacons and the setting out of the Works in accordance with the co-ordinates indicated on the construction drawings.

PS 5.12 Accommodation and Care of Employees

No employees, apart from a security guard, may be housed on the Site of Works. The Contractor shall make his own arrangements to secure the facilities provided for under the Contract.

PS 5.13 Marking

All plant including steel piping and specials delivered under this Contract shall have painted or marked thereon or on the container the relative item number given in the Bill of Quantities.

PS 5.14 Off-Loading, Stacking and Liability for Breakages

The Contractor will be required at his own expense to make all arrangements for off-loading and carefully stacking all plant delivered under this Contract at the Site of the Works. The off-loading and stacking shall be carried out strictly in accordance with the requirements of the Employer's Agent so as to permit a thorough and careful examination and testing of all items for breakages, fractures, etc. and any routine maintenance during storage.

The Contractor shall be fully responsible for the protection of all plant delivered by him to Site but still in storage, against damage by water, weather, fire and any other interference until such time as it is erected and installed, put into satisfactory operation and accepted by the Employer as complete.

PS 5.15 Storage

Johannesburg Water has no storage facilities available for use by the Contractor who must make his own arrangements in this regard.

The Contractor will be permitted to establish a stores yard and to erect presentable temporary buildings for the storage of materials and for offices and latrines, all of which shall be neatly fenced. The fence must be sturdy, covered with diamond mesh wire and fitted with a lockable vehicle entrance gate and shall be at least 2 m in height.

The Contractor shall make his own arrangements to secure the facilities provided.

The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

Upon completion of the work in terms of this Contract, the site must be cleared of all structures, concrete slabs and waste. The area is to be rehabilitated according to the Specification.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

PS 5.16 Inspection at Site

All plant will be carefully examined upon delivery at the Site by the Employer's Agent's representative and all items showing defects or damage of any description shall be laid aside as not being in accordance with the requirements of the Contract and these shall be removed and replaced by the Contractor at his own cost.

PS 5.17 Temporary Housing, Stores, etc.

The Contractor shall provide and maintain at his own cost all sheds of a temporary nature necessary for the accommodation and proper protection of plant from damage or loss. These are to be erected only on sites which shall have been approved by the Employer's Agent and they shall be removed as soon as their necessity ceases and the site thereof restored to its original condition and the ground left clean and sanitary.

PS 5.18 C.Management Meetings

Meetings will be held every month with the first meeting called the site handover meeting. The Contractor will be supplied with an appropriate agenda for the management meetings and meetings will be chaired by the Employer's Agent or his duly appointed representative. The Employer's Agent or his duly appointed representative will be responsible for issuing of the minutes.

PS 6 MANAGEMENT OF THE WORKS

PS 6.1 Applicable SANS 1921 Standards

Although not bound in or issued with this document, the following SANS 1921 Construction and Management Requirements for Works Contracts as approved by the Council of the South African Bureau of Standards shall apply to this Contract. The Contractor shall be in possession of these Standards and shall keep a copy of it on site for reference by him and the Employer's Agent for the duration of the Contract.

PS 6.2 Planning and Programming

An initial programme in terms of the Clause 5.6 of the GCC (2015), complete with a cash flow budget for the execution of the works must be made available to the Employer's Agent for approval within 21 days after the receipt of the Letter of Award. Aspects that will require co-ordination with the Employer must be indicated clearly and provision must be made for it in the programme.

The programme shall be in the form of a gant chart and shall clearly show the anticipated quantities of work to be performed each month, together with the manner in which the listed plant is to be used, as well as the cash flow for the various sections of work. The Contractor must take cognisance of the following when developing the programme:

1. Sequence of the works for the relevant works area.
2. Target dates for the tasks identified in sequence of the works for the relevant working areas.
3. Materials requirements.
4. Construction Plant to be used.
5. Services affecting construction.
6. Any factors that could affect construction progress after commencement.

No deviation from the approved sequence of construction shall be accepted without prior written approval.

No work of a permanent nature may be executed before the programme has been approved by the Employer's Agent.

All method statements shall be approved by the Employer's Agent before commencement of construction. In order to minimize the impact on traffic, pedestrians and business the Contractor will be required to segment the works in such a manner that no portion of the works is more than one day ahead of the following position i.e. trenches cannot be excavated more than one day ahead of pipe laying, pipes more than one day in advance of manhole construction and finishing off etc. These segments of the works shall be clearly defined in the Contractor's method statement for each work area.

If, during the progress of the work, the quantities of work performed per month fall below those shown on the programme, or if the sequence of operations is altered, or if the program is deviated from in any other way, the Contractor shall, within one week after being notified by the Employer's Agent, submit a revised programme.

If the programme is to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing the modifications to the original programme that are necessary to ensure completion of the Works or any part thereof within the time for completion. Any proposal to increase the rate of work shall be accompanied by positive steps to increase production by providing more labour and plant on the Site, or by using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to submit or to work according to the programme or revised programme shall be sufficient reason for the Employer to take steps as provided for in the GCC (2015).

The approval by the Employer's Agent of any programme shall have no contractual significance other than that the Employer's Agent would be satisfied if the work is carried out in accordance to such programme and that the

Contractor undertakes to carry out the work in accordance with the programme. It shall not limit the right of the Employer's Agent to instruct the Contractor to vary the programme should circumstances make this necessary.

Where the Contractor's programme indicates completion beyond the official contract completion date, and the programme is accepted by the Employer's Agent, such acceptance shall in no way whatsoever indicate the Employer's Agent's acceptance of an extension to the contract period. Nor shall it be acceptable in terms of Clause 5.6.5 of the GCC (2015) as notification of an intention to claim. It shall, however, indicate that the Contractor has taken due cognizance of the completion date and of the consequent possible application of penalties.

PS 6.3 Planning

The Contractor shall ensure that he delivers goods and services timeously, to not unnecessarily delay other contractors, service providers and suppliers.

PS 6.4 Programming

It will be an explicit requirement of the contract that this programme is updated monthly and submitted to the Employer's Agent at least two working days prior to the monthly site progress meeting. The programme shall at minimum contain:

PS 6.4.1 Time Scale Minimum

1. Days, where the period does not exceed three months.

2. Weeks, where the project period exceeds three months.

3. Months, where the period does not exceed one year.

4. Years, where the project period exceeds one year.

PS 6.4.2 Tasks

Where phases or stages are anticipated, this shall be the highest level of division and all tasks related to the successful accomplishment of that phase

of the area shall be grouped. Resources allocation and task dependency shall be indicated.

PS 6.4.3 Start and Finish Dates

All tasks shall have specific start and finish dates.

PS 6.4.4 Critical Path

All tasks forming the programme line that will establish any delays in the overall Contract Period shall be clearly indicated and an indication of their sensitivity characteristics shall be provided.

PS 6.4.5 Progress Tracking

The Contractor shall be required to periodically indicate progress per task graphically and on a percentage basis.

PS 6.4.6 Non-working Time

South African public holidays, weekends and the local traditional annual builder's break shall be incorporated in the programme.

PS 6.4.7 Sequence of the works

The Contractor shall supply his proposed sequence of work together with the initial programme & the sequence of works to be executed shall be agreed between the Employer's Agent and the Contractor.

PS 6.4.8 Software Application for Programming

The construction programme shall be completed in Microsoft Office Project Professional 2010 or compatible software. It shall show the activities planned start dates, planned end dates and planned durations. The construction programme and updated versions thereof shall be made electronically available to the Employer's Agent.

The programme shall be costed in accordance with the Bill of Quantities and resourced accordingly.

PS 6.5 Methods and Procedures

The methods and procedures for the execution of the works shall be in accordance with the standard specifications and the variations and additions thereto.

The Contractor will advise in his tender the methods and procedures that he proposes in performing the Works. These methods and procedures shall not be deemed as terms of the Contract. The Contractor is also allowed to change his methods and procedures as he sees fit subject to the change being approved by the Employer's Agent. Methods and procedures will not vary the specification and cannot be used to provide qualifications to the proposed agreement. The intention of the method statement is to provide the Employer's Agent and the Employer with information as how he proposes to perform the said works.

PS 6.6 Quality Plans and Control

In addition to guidelines set out in GCC 2015 Clause 7, the Contractor will furnish the Employer's Agent with a Quality Assurance and Control Plan that incorporates all of the requirements of this specification within three weeks of the Letter of Award of the contract. 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 experienced personnel, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the works at all times.

All material, plant and equipment shall be of the best quality available and shall, where applicable, comply with the relevant standard specifications of the SANS. In cases where no specification of the SANS exists, the relevant British, German or American specifications will be applicable as determined by the Employer's Agent. The latest amendments of these specifications shall apply.

The Contractor shall submit for the approval of the Employer's Agent and before any orders are placed, the names of the firms from which he proposed to obtain his supplies of materials and manufactured articles.

He shall also supply samples as and when required by the Employer's Agent.

The Employer's Agent may also, in exercising the powers vested in him, order the Contractor to remove all or any of the material and equipment which, in his opinion, is of an inferior quality and to replace them with proper materials or equipment at his own expense.

The cost of supervision and process control will be deemed to be included in the rates tendered for the related items of work.

On completion and submission of every part of the Works to the Employer's Agent for examination, the Contractor shall furnish the Employer's Agent with proof of quality in the form of a data pack containing measurements and levels to indicate compliance with the scope of work.

Notwithstanding anything contained in this document, nor any examination of the Works by the Employer's Agent, nor any tests carried out, nor any approvals granted (verbally or in writing), nor any consent that may have been given, either directly or implied, nor anything that may be construed to the contrary, the Contractor shall remain fully and solely accountable for correctly setting out, founding and constructing the Works, and for compliance with the specifications and the drawings.

PS 6.7 Accommodation of Traffic on Public Roads Occupied by the Contractor

The Contractor is responsible for pricing traffic accommodation in his tender if applicable. The Contractor, in understanding his site operations, may require traffic accommodation and therefore will have to comply with prevailing local and /or national guidelines in this regard. The Contractor shall make applications to the relevant authorities for such permissions. The timing and contractual risk of such applications shall be for the Contractors account. The Employer's Agent, without prejudice, may assist in this regard.

PS 6.8 Other Contractors on Site

During the course of the contract, other contractors may be involved in construction projects within and in the vicinity of the site, which may be inter-related to the work being undertaken on this contract.

The Contractor shall cooperate with other such contractors and shall provide them with all reasonable access to enable them to carry out their work. Access may be required, from time to time, by these contractors and the Contractor shall take all reasonable steps to accommodate such requirements.

No claims, related to works being carried out by other contractors, will be entertained by the Employer.

PS 6.9 Testing, Completion, Commissioning and Correction of Defects

PS 6.9.1 General

The onus is on the Contractor to produce work that will conform in quality and in accuracy of detail to the requirements hereinafter specified. The Contractor shall clearly understand that it is not a duty of the Employer's Agent or his representative to act as foreman or surveyor on the Works.

The Contractor shall, at his own expense, provide an experienced Site Agent, foremen and surveyors together with all transport, instruments and equipment for supervising, checking and controlling the work.

The act of passing any completed work for payment by the Employer's Agent shall not be construed as signifying approval or acceptance thereof. Failure on the part of the Employer's Agent to reject any defective work or material shall not in any way relieve the Contractor of his obligations under the Contract, nor prevent later rejection when such work or material is discovered. In this regard, it is emphasised that notwithstanding anything contained in this document, any tests that may have been carried out, any consent that may have been given, either directly or implied, and anything that may be construed to the contrary, the Contractor shall remain fully and solely accountable for the Works and for compliance with the specifications and the drawings.

The Contractor shall, when submitting any work to the Employer's Agent for examination, satisfy himself by testing, measurement and otherwise as may be necessary that the work does in fact meet the requirements of the Specifications. This information shall be submitted with the Contractor's request for examination and the Employer's Agent shall decide on the number and type of tests, measurements, etc. required to enable him to judge the quality of the work. The submission of this information shall in no way diminish the authority of the Employer's Agent to conduct such tests as he may consider necessary in order to determine the quality of the work performed by the Contractor, nor will he be bound to take account of the Contractor's tests, measurements, etc. should he consider these to be either incorrect or not representative.

Quality control and completion tests shall be in accordance with the relevant standard and amended specifications and additional specifications.

The tendered rates shall include the cost of all control testing, and no additional claims shall be entertained in this respect. This includes the supply of all necessary equipment required for these tests and/or inspections by the Employer's Agent.

Should the control testing performed or arranged by the Contractor not meet the requirements of the specification, the Employer's Agent shall have the right to conduct all such testing at the Contractor's expense.

In such a case, the Employer's Agent shall be given at least 72 hours' notice when testing is required. No claims, however, shall be considered in respect of delays resulting from such testing.

Whenever the Employer's Agent conducts control testing on behalf of the Contractor, charges shall be levied. The Employer's Agent may, from time to time, carry out his own check tests on the work performed by the Contractor. Should such check tests show the Contractor's control testing to be such that the quality of the Contractor's work can be called into question, then the

Employer's Agent may order further check tests to be carried out on work already completed by the Contractor.

All costs associated with such check tests shall be for the Contractor's account as shall the costs of any other check test whose results do not comply with the specification.

Where the Employer's Agent is required to witness certain control tests, such as the pressure testing of pipelines, and the results of such tests do not comply with the specifications, then charges will be levied against payments to the Contractor in order to recover the costs of the Employer's Agent's presence at the test.

The requirements of the Local Authority, insofar as their witnessing of tests, shall be adhered to.

PS 6.9.2 Performance Tests

General

The Contractor shall carry out all tests required to satisfy the Employer's Agent that the plant is capable of performing the duties prescribed in the Specification, and shall allow for this in his Tender. Any defects detected during the testing operation shall be made good by and at the expense of the Contractor, including all additional costs incurred by the Employer and his representatives and the Employer's Agent. These tests shall be carried out to certify that the plant, as installed on Site is operating in accordance with the specified and guaranteed hydraulic, mechanical and electrical performance of the equipment and must be witnessed by the Employer's Agent. Three copies of reports on all tests shall be submitted within one week after the tests have been carried out.

The Employer's Agent will be entitled to be present at such test and the Contractor shall give the Employer's Agent reasonable notice of the dates of the test.

PS 6.9.3 Factory Tests

The Contractor shall carry out tests in accordance with the requirements of the recognised SANS, IEC or BS standards. Comprehensive details of the standards used and to which equipment the tests will be applicable shall be supplied. Such additional tests in the manufacturer's "Works", which in the opinion of the Employer's Agent are necessary to determine that the Contract work complies with the requirements of the Specification, whether under test conditions or in normal service, may be called for at no additional cost to the Employer.

PS 6.9.4 Tests on Site

All Site tests shall normally be carried out in the presence of, but always to the satisfaction of the Employer's Agent and at such times as he may reasonably require. The Contractor shall provide all the relevant test equipment and bear the costs of all testing to be done. All equipment must be tested to ascertain whether it performs its intended duties in a manner as specified.

PS 6.9.5 Accepted Laboratories

Unless otherwise stated in a specification that forms part of this Contract, only the testing laboratories of the South African Bureau of Standards, the Council of Scientific and Industrial Research, the relevant Government Departments and Local Authorities will be accepted as approved laboratories in which tests or design work required in terms of a specification may be carried out.

PS 6.9.6 Methods of Testing

Unless otherwise prescribed in a specification that forms part of this Contract, all testing shall be carried out and interpreted in strict accordance with the methods specified in relevant SANS, IE or BS Specification(s).

PS 6.9.7 Inspection of Works by Local Authority

The Contractor shall afford inspectors from the Local Authority reasonable access to all parts of the site. The Employer's Agent in the presence of representatives of the Local Authority will generally undertake testing of the works. Accordingly, the Contractor shall notify the Employer's Agent at least

24 hours in advance as to when the various sections of work will be available for testing. The Employer's Agent may require the Contractor to submit a weekly schedule of times, based on his programme, that he envisages work to be available for testing.

PS 6.9.8 Commissioning of Equipment

Before starting up any section of the mechanical plant or filling tanks and sumps with liquid, the Contractor shall clean out the tanks or structures or, if necessary, arrange with the Main Contractor to remove any building rubble from the structures, check that all nuts are tightened correctly, that all equipment is complete and ready for start-up, that the plant has been installed correctly and that three copies of the operating manuals have been handed over.

PS 6.9.9 Servicing and Defects Liability Period

Without limiting in any way, the obligations or responsibilities of the Contractor for maintenance, the Contractor shall make regular quarterly visits to the reservoir during the Defects Liability Period to supervise the maintenance of the equipment. During these visits, he shall make all adjustments and do everything necessary to ensure the proper running of the plant. After each supervising visit to the Site, the Contractor shall submit to the Employer's Agent a report on:

a. The condition of the equipment and the servicing work carried out, and

b. Any adjustments which may have been made.

The last servicing visit shall be carried out during the last week of the Defects Liability Period during which visit the Contractor's representative shall carry out full checks on the equipment to ensure that the alignment, clearances and any other setting are correct, and he shall carry out any adjustments necessary. The Defects Liability Period will not terminate until the Employer's Agent is satisfied that the Contractor has finally checked the adjusted equipment.

Servicing will be measured as scheduled by the number of visits.

The dates for the service visits shall be agreed with the Employer's Agent during the final inspection prior to issue of the certificate of completion.

PS 6.9.10 Operating and Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions.

The Contractor must compile and provide three copies of a complete operation manual for the equipment provided. This manual shall contain comprehensive information as set out hereafter.

a. Drawings of the equipment detailing all part numbers and materials.

b. A complete spare list.

c. A lubrication and maintenance schedule showing all maintenance and lubrication operations, their recommended frequency and the grades of lubricant required.

d. A maintenance brochure describing all maintenance, adjustment and replacement procedures.

e. Operating manual describing the operation of the equipment with performance curves where applicable.

f. A manual detailing all dismantling and reassembly procedures.

g. Maintenance procedure for corrosion protection painting systems.

h. Complete Data book of the equipment on completion of the Contract.

The Contractor shall amplify and amend such drafts until the Employer's Agent is satisfied that they will fulfil the purpose of ensuring that the Employer's staff is adequately instructed to operate and maintain the works. Once the drafts

have been approved by the Employer's Agent, the Contractor shall prepare three suitably bound copies and deliver them to the Employer's Agent.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that it may be used frequently without falling apart. Standard pamphlets may be supplied as addenda, bound separately in a good quality file to serve as a reference but will not be allowed as part of the main manual. The Contractor shall allow in his tender price for the supply of these operating and maintenance instructions.

In addition to the above, the Contractor, and where necessary the suppliers of equipment, will be required to instruct the works personnel in the proper and correct operation of the equipment installed for a maximum period of 14 days. The timing of this training will be determined in consultation with the Employer and the Employer's Agent.

The manuals shall be drawn up in English.

PS 6.9.11 Completion, Commissioning and Correction of Defects

The tendered rates shall include the cost of all activities and tests that may be required in ensuring proper completion and commissioning of the Works, and no additional claims shall be entertained in this respect. This includes the supply of all necessary equipment required for such and / or for inspections by the Employer's Agent and any other relevant authority.

Any defect in the Works shall be corrected to the satisfaction of the Employer's Agent.

PS 6.10 Recording of Weather and Abnormal Rainfall

If during the time for completion of the works or any extension thereof, abnormal rainfall or wet conditions shall occur, then an extension of time in accordance with Clause 5.12 in GCC 2015 hereof shall be granted by the

Employer calculated in accordance with the formula given below for each calendar month or part thereof.

V = (Nw Nn) + ((Rw Rn)/X)

V	Extension of time in calendar days in respect of the calendar month under consideration.
Nw	Actual number of days during the calendar month on which a rainfall of Y mm or more has been recorded.
Nn	Average number of days, as derived from existing rainfall records, on which a rainfall of Y mm or more has been recorded for the calendar month.
Rw	Actual 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.

For purposes of the contract Nn, Rn, X and Y shall have those values assigned to them in the Contract Data and/or the Specification.

The total extension of time shall be the algebraic sum of all monthly totals for the period under consideration, but if the total is negative the time for completion shall not be reduced due to subnormal rainfall. Extensions of time for part of a month to be calculated using pro rata values of Nn and Rn.

This formula does not take account of flood damage that could cause further or concurrent delays and will be treated separately as far as extension of time is concerned.

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

The following average rainfall figures are applicable:

Information Source: South African Weather Service,
Pretoria, Tel.: 012 367 6014

Y = 10 mm/24-hour day

X = 20 mm

STATISTICAL INFORMATION: MIDRAND: LATEST		
Month	**RAINFALL**	
	Nn	**Rn**
	Actual number of days during the calendar months in which a rainfall of more than Y mm has been received	*Average monthly rainfall*
January	2.4	140.7
February	1.3	69.4
March	0.9	45.4
April	0.2	32.6
May	0.3	15.9
June	0.0	6.0
July	0.0	0.8
August	0.0	3.2
September	0.1	5.4
October	1.3	48.9
November	1.2	63.7
December	1.9	107.1
TOTAL	**9.5**	**539.1**

The Contractor shall be permitted to take his own rainfall measurements on site subject to the Employer's Agent's approval, but access to the measuring gauge(s) shall be under the Employer's Agent's control. The Contractor is to provide and install all the necessary equipment for accurately measuring the rainfall as well as to provide, erect and maintain a security fence plus gate, padlock and keys at each measuring station, all at his own cost.

PS 6.11 Format of Communications

All communication shall be in writing and any verbal agreements shall only be binding once confirmed and agreed to in writing. Communication by registered post, email or facsimile is acceptable.

The Contractor and the Employer shall follow the correct communication protocol applicable to a normal civil engineering contract. The Contractor shall not put into effect any instructions received by him, other than through such protocol.

Should the Contractor be unclear in this regard, he shall obtain a ruling from the Employer's Agent.

Contractor to provide the following reporting on a monthly basis, Local resources reporting shall include but not be limited to;

a. Number (labourers, SMMEs and suppliers)

b. Labour:

- Process of recruitment, selection and appointment
- Name and surname
- Gender and age
- Certified copies of ID not validated older than three months.
- Proof of Compliance with COID Act, which will be valid for the duration of the Construction period.
- Contact details (address, telephone numbers and ward number)
- Contract signed
- Duration of appointment
- Commencement date
- Termination date

- Activity performed
- Classification (Skilled, semi-skilled or unskilled (labourer))
- Time or task rate
- Allocated Supervisor/foreman
- Health and Safety induction undergone
- Training provided:

  Trainer details

  Type of training

  Duration of training

  Cost of training

  Attendance register

- Performance rating (good, fair, poor):

  For training

  Work execution

  Health and safety awareness

- Additional training or supervision to be provided
- Proof of Monthly and cumulative payments, including salaries or wages
- UIF Returns
- Certified copy of the contractual agreement not validated older than three months.

c. SMMEs

- Process of recruitment, selection and appointment
- Company name

- Company contact details (address, telephone numbers and ward number)
- Company registration (also VAT and TAX)
- Company age (months or years)
- Type of company
- Company size (number of permanent employees)
- Name and surname of owner
- Owner contact details (address and telephone numbers and ward number)
- Gender, age and PDI status
- Contract signed
- Certified copies of ID
- Proof of Compliance with COID Act, which will be valid for the duration of the Construction period.
- Duration of appointment:

  Commencement date

  Termination date

- Resources provided (labour and/or plant and/or materials)
- Activity performed
- Classification
- Time or task rate
- Allocated Contractor Supervisor/foreman
- Health and Safety induction undergone
- Training provided:

Trainer details

Type of training

Duration of training

Cost of training

Attendance register

- Performance rating (good, fair, poor):

  For training

  Work execution

  Health and safety awareness

- Additional training or supervision to be provided
- Proof of Monthly and cumulative payments , including salaries or wages
- UIF returns
- Certified copy of the contractual agreement not validated older than three months

d. Suppliers

- Process of recruitment, selection and appointment
- Company name
- Company contact details (address, telephone numbers and ward number)
- Company registration (also VAT and TAX)
- Company age (months or years)

- Type of company
- Company size (number of permanent employees)
- Name and surname of owner
- Owner contact details (address and telephone numbers and ward number)
- Gender, age and PDI status
- Contract signed
- Duration of appointment:

  Commencement date

  Termination date
- Resources provided (plant and/or materials)
- Activity performed
- Allocated liaison
- Health and Safety induction undergone
- Performance rating (good, fair, poor)
- Monthly and cumulative payments

The report format may be amended from time to time by the Employer's Agent. However, the initial format shall be finalised by the Employer's Agent in association with the Contractor.

A Daily Site Diary shall be used by the Contractor for recording day by day the state of the weather, the work done each day and full details of any circumstance which may affect the progress of the works. One original sheet and two copies shall be used for each day. The original sheet of each set of 3 pages will be retained by the Employer's Agent or his representative. The Contractor may remove the second sheet, but the third sheet shall be retained on the site until completion of the Works, when it shall be handed over to the Employer's Agent.

PS 6.12 Key Personnel

The Contractor is deemed to have in making his offer, all personnel available to perform the works entirely in the contracted time and cost. In addition, he shall comply with the prevailing Act 85 of 1993, Occupational Health and Safety Act.

The Contractor is to provide the Curricula Vitae of key personnel to be employed on the project as well as the person's position and responsibilities within the project team. The Contractor shall provide the following minimum key staff:

a. Contracts Manager
b. Site Agent
c. Quality Manager/Auditor/Controller
d. Health and Safety Officer/s; and
e. Foremen
f. SMME supervisor

PS 6.13 Management Meetings

The Employer's Agent shall hold regular site meetings with representatives of the Contractor, and the Employer. Minutes of such site meetings shall be kept and distributed by the Employer's Agent. Senior Contractor management staff attendance shall be compulsory.

The Contractor shall be required to provide reporting with regard to project progress, resources (human, plant and equipment), community issues, environmental and health and safety aspects.

PS 6.14 Forms for Contract Administration

The Contractor shall maintain a file which shall contain project information related to project progress, resources (human, plant and equipment), community issues, environmental, health and safety aspects, penalties

imposed, claims lodged and outcomes, disputes and resolutions, payment and variations.

PS 6.15 Daily Records

In addition to records on rainfall and weather, labour, plant, and materials, a site diary, site instruction book (both in triplicate) and safety documents are to be provided and maintained by the Contractor on site and updated daily.

These shall be submitted to the Employer's Agent on completion of the contract.

PS 6.16 Bonds and Guarantees

The Contractor shall within the period stated in the Contract Specific Data, of this document, provide the Employer with a Surety Bond in the form of a Bank Guarantee, Bank Transfer or a Guarantee from an approved Insurance Company to the satisfaction of the Employer in the form included in the Tender Documents. The Bank Guarantee shall be for an amount equal to ten per cent (10%) of the Tender Sum, for the due and punctual fulfilment and completion of all the Contractor's obligations under the Contract. No Extension of Time or any variation of the Contract nor the termination of the Contract by the Employer in terms of GCC 2015 hereof shall in any way impair, diminish or terminate any liability to the Employer under and by virtue of such Surety Bond. The cost of the Surety Bond to be so entered into, shall be at the expense in all respects of the Contractor; the Surety Bond to be released upon issue of the Employer's Agent's Certificate of Completion of the Works, unless otherwise stated in the Contract Data.

Should the Contractor, when notified of the acceptance of his offer, fail to provide an approved Surety Bond within the stated period, then the Employer may, at his sole discretion:

a. Grant the Contractor a further reasonable period in which to provide the bond; or

b. Withdraw his acceptance of the tender, in which case the Contract shall be deemed to be void, but without prejudice to the Employer's rights to recover whatever damages he may have suffered by virtue of the Contractor's failure to fulfil his obligations.

PS 6.17 Payment Certificates

Monthly payment certificates shall be submitted by the Contractor in the format approved by the Employer's Agent. Once agreement has been reached with the Employer's Agent on the value of the certificate, the Contractor shall submit an original invoice on which payment will be made. The format will be discussed in the month preceding the first claim and will be resolved before the first payment is made.

Payment for particular items scheduled shall conform to the applicable payment clauses of the Pricing Data, Project Specifications and the Particular Specifications.

Where retention money is applicable to a Contract, the retention money shall be deducted on the invoice from the total amount for work done and then the Value Added Tax (VAT) added to calculate the total amount payable on the invoice.

If penalties are payable, they will be deducted prior to the addition of (VAT) but after the calculation of retention.

Tax invoices shall be submitted for each interim payment claim. The Contractor shall submit a provisional invoice with his payment claim as soon as possible after the date of measurement.

The tendered rates or sums shall cover the cost of drawings and instructions for anything not specially mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment in complete working order), to enable the equipment as described to be installed and/or function safely and correctly as specified.

If any material on site is claimed, proof of ownership shall be provided, either by means of receipts, or by means of letters from the suppliers, stating that ownership has been transferred to the Contractor.

No claims whatever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned in the Schedule of Quantities.

Payment for "supply and delivery", "install and commission", "servicing" and "tools and spares" is respectively defined in PS 3.2, PS 5.9.3, and PS 5.9.4.

Before becoming entitled to any of the above payments, the Contractor shall lodge with the Employer's Agent three copies of a detailed invoice showing the amount claimed as well as a claim form in triplicate complete by item as scheduled in a format approved by the Employer's Agent.

Payment Certificates shall be delivered to the Employer's Agent by the 15th of each month.

PS 6.18 Foreign Exchange Risk

The provision of forward cover against foreign exchange fluctuations on the imported content of all equipment required under the contract might be required. In his Tender, the Tenderer must state the value of the imported content of each item and the applicable currencies and the exchange rates on which his tender was based.

The successful Tenderer might be required to take out forward cover on all foreign exchange transactions required in his tender for this contract, the rate applied shall be that ruling at the date of commencement of the Contract that is stated in the Letter of Acceptance.

Amounts tendered will be adjusted for foreign exchange variations up to the date of commencement of the Contract; any fluctuations after this date will be for the Contractor's account.

PS 7 FEATURES REQUIRING SPECIAL ATTENTION

PS 7.1 General Conditions of Contract (GCC)

The Contract Document is compiled in accordance with the General Conditions of Contract for Construction Works, Third Edition (2015) and Tenderers are therefore required to price the Tender accordingly.

PS 7.2 Security

The Contractor shall be responsible to provide his own security on site, as he deems necessary. The Employer shall not be held responsible for any loss or damage suffered by the Contractor, his plant, equipment, materials, Sub-Contractor or employees as a result of a security incident of any nature.

PS 7.3 Operation of Valves

Only employees of Johannesburg Water SOC. are permitted to operate existing water valves.

Requests for isolation of any section of such reticulation shall be made to the relevant section of the local authority at least 4 working days in advance of the requirement for isolation. The Employer's Agent shall be advised of the requirement and will monitor the implementation of the request.

PS 7.4 Work Outside Normal Working Hours

The Contractor is permitted to work outside of normal working hours (07:00 to 17:00) only upon obtaining written permission from the Employer's Agent.

Should the Contractor choose to work outside normal working hours without having been ordered to do so by the Employer's Agent, permission will not be unreasonably denied but all additional costs arising out of such work shall be entirely to the Contractor's account.

PS 7.5 Contract Award

The Contract shall be awarded to one main Contractor. It is an explicit requirement of this Contract that the work of the various disciplines be executed

by competent staff and/or Sub-contractors. The Contractor will be responsible for the coordination of his own work and that of any sub-contractors.

PS 7.6 Additional Meetings

The cost of all additional meetings or inspections over and above the normal that takes place because of the Contractor not keeping to his program or because of the quality of his work will be for the account of the Contractor and will be deducted from the following payment certificate. An amount of R 5 000.00 per meeting will be paid by the Contractor to compensate for the travelling cost, time, etc. of both the Employer's Agent and the Employer.

PS 7.7 Community Liaison and Community Relations

For the purpose of this project, a community liaison officers will be required to inform the community regarding the Contractor's activities on this project.

PS 7.8 Sanitary Facilities

The Contractor shall provide his own sanitary facilities. See Clause 5.19 of the Occupational Health and Safety Specification forming part of Volume 3.

PS 7.9 Control of Pipe Manufacturing

The Contractor shall inform the Employer's Agent and the inspection authority timeously of his program and place of manufacturing so that the necessary inspections can be arranged for. Copies of all test records must be delivered to the Employer's Agent before a Certificate of Completion will be issued.

PS 7.10 Waterproofing

Where any work pierces waterproofing, installation shall be as approved. Supply all necessary sleeves, caulking and flashing required to make openings absolutely watertight. The cost of complying with these requirements shall be deemed to be included in the unit rates tendered for the items affecting the waterproofing.

PS 7.11 Local Labour

The Contractor's attention is drawn to Clause 1.4(d) of the Environmental Management Plan (Volume 3) regarding the preferential employment from local communities of labourers and where available skilled artisans.

The Contractor's shall pay Local Labour rates in accordance with the following:

GOVERNMENT GAZETTE, 17 December 2021, No. 45645. DEPARTMENT OF EMPLOYMENT AND LABOUR NO. R. 1605, LABOUR RELATIONS ACT, 1995, BARGAINING COUNCIL FOR THE CIVIL ENGINEERING INDUSTRY (BCCEI): RENEWAL OF PERIOD OF OPERATION OF THE WAGE AND TASK GRADE COLLECTIVE AGREEMENT.

and any subsequent update to the BCCEI Collective Bargaining Agreement, that may be gazetted by the Department of Employment and Labour or the BCCEI during the execution of this Contract.

It is expressly noted that the rates contained in the aforementioned Gazette or Collective Bargaining Agreement will apply to the Contractor or subcontractor(s) irrespective of whether the Contractor or subcontractor(s) is a member of the employer's organisations listed in the Gazette, or not.

It is equally noted that the rates contained in the aforementioned Gazette or Collective Bargaining Agreement will apply to all employees employed for the purposes of executing the Contract (and specifically those defined as local labour) irrespective of whether those employees are members of the trade unions listed in the gazette, or not.

PS 8 HEALTH AND SAFETY SPECIFICATION FOR CONSTRUCTION WORK

Contractors are to prepare Health and Safety Plans in accordance with Johannesburg Water's Health and Safety Specification (refer to Volume 4: Occupational Health and Safety Specification and Environmental Management Plan for Capital Investment Projects). The legal imperatives for this requirement stem from the Construction Regulations (2014), and more specifically the following:

Regulation 4(1)(a): An Employer shall prepare a documented health and safety specification for the construction work, and provide any principal Contractor who is making a bid or appointed to perform construction work for the Employer with the same.

Regulation 4(1)(d): An Employer shall take reasonable steps to ensure that each principal contractor's health and safety plan is implemented and maintained on the construction site.

Regulation 4(2): An Employer shall discuss and negotiate with the principal Contractor the contents of the health and safety plan and thereafter finally approve the health and safety plan for implementation.

Regulation 5(1): A principal Contractor shall provide and demonstrate to the Employer a suitable and sufficiently documented health and safety plan, based on the Employer's documented health and safety specification.

Regulation 5(1)(a): A client shall prepare a baseline risk assessment for an intended construction work project.

Regulation 5(1)(b): A client shall prepare a suitable, sufficiently documented and coherent site-specific health and safety specification for the intended construction work based on the baseline risk assessment contemplated in regulation 5(1)(a).

Regulation 5(1)(l): A client shall discuss and negotiate with the principle contractor the contents of the principle contractor's health and safety plan contemplated in regulation 7(1), and must thereafter finally approve that plan for implementation.

Regulation 5(1)(n): A client shall take reasonable steps to ensure that each contractor's health and safety plan contemplated in regulation 7(1)(a) is implemented and maintained.

Regulation 7(1)(a): A principal contractor must provide and demonstrate to the client a suitable, sufficiently documented and coherent site specific health and safety plan, based on the client's documented health and safety specifications contemplated in regulation 5(1)(b), which plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the principal contractor as work progresses.

PS 8.1 Project-Related Occupational Health and Safety Risks

According to the Construction Regulations (2014), a Health and Safety Plan "means a documented plan which addresses hazards identified and includes safe work procedures to mitigate, reduce or control the hazards identified". Apart from complying with the Health and Safety Specification (Volume 3), specific attention is drawn to the identification and assessment of risks. The tendering Contractors are required to consider inter alia the following risks (where applicable):

- Excavation and safeguarding of trenches
- Collapse of the excavation walls
- Workers or onlookers falling into the excavations
- Safeguarding of deep excavations
- Working in elevated positions
- Scaffolding
- Traffic control (heavy machinery)
- Plant and machinery operation

- Working around heavy machinery
- Existing services
- Offloading of material
- Electrical Distribution boards
- Electrical Installation
- Making of steel items
- Laying of pipes
- Placing concrete
- Machine operator
- Third party exposures
- Use of portable electrical tools
- Location of site camp
- Storage and handling of material
- Storage of hazardous material
- Fire prevention and protection
- Refuelling vehicles/plant
- Welding
- Handling of compressed gas cylinders

Safe work and emergency procedures need to be prepared to address the abovementioned risks.

PS 8.2 Guide to Risk Assessments

PS 8.2.1 Nine Steps to Effective Risk Assessments

Step 1: Identifying the current as well as emerging hazard, risks or exposures.

Step 2: Aim to identify major hazards, don't waste time on the minor and detail except if such hazard has the potential to repeat itself on a frequent basis.

Step 3: Involve as many people as possible in the ongoing risk assessment process especially those at risk.

Step 4: Gather all the information and analyse it.

Step 5: Look at what actually could or has occurred including non-routine operations.

Step 6: Use a systematic approach to ensure all hazards are adequately addressed.

Step 7: Assess the risks identified or the risk has occurred by taking into account the effectiveness of current as well as controls under consideration.

Step 8: Ensure the process is practical, realistic, cost and business effective.

Step 9: Always record the assessment in writing including i.e. assumptions, date and why a particular decision has been made.

PS 8.2.2 How Serious Is It?

Probability		Consequences
A	Common	1 Fatality or permanent disability.
B	Has Happened	2 Major injury.
C	Could Happen	3 Average Lost Time Injury.
D	Not Likely	4 Minor Injury.
E	Practically impossible	5 Medical Treatment or less.

Consequence	Probability A	B	C	D	E
1	1	2	3	4	5
2	2	3	4	5	6
3	3	4	5	6	7
4	4	5	6	7	8
5	5	6	7	8	9

Risk rating		Action
1 - 3 =	Serious	Immediate (within 1 week).
4 - 5 =	High	Within 1 month.
6 - 7 =	Moderate	> 4 weeks.
8 - 9 =	Acceptable	No action but will consider from time to time.

PS 9 ENVIRONMENTAL MANAGEMENT PLAN

Contractors are to adhere to the mitigation measures listed in the Environmental Management Plan (EMP) (refer to Volume 4: Occupational Health and Safety Specification and Environmental Management Plan for Capital Investment Projects). Environmental mitigation measures are actions needed to align a project implementation phase with environmental control principles, where potential impacts to the natural and social environment are prevented, minimised or remediated. Environmental safeguarding is governed by various sets of legislation, with the most noteworthy for this project constituting the National Environmental Management Act (No. 107 of 1998) and the National Water Act (No. 36 of 1998).

Cost incurred due to the above shall be included in the scheduled rates in the Pricing Data.

PS 10 HEALTH AND SAFETY AGENT AND ENVIRONMENTAL CONSULTANT

The contact details for the Health and Safety Agent and for the Environmental Consultant are:

Health & Safety Agent	Environmental Consultant
Company: Johannesburg Water SOC	Company: Johannesburg Water SOC

Name: Mpho Mosia	Name: Joyce Ngobele
Contact details: 011 688 1476	Contact details: 011 688 1443

PS 11 GENERAL SECTION PAYMENT LIMITATION

The gross sum of items 8.3 and 8.4, as per SANS 1200A, may not exceed 15% of the total contract amount excluding contingencies and VAT. If the amount tendered for these items exceeds the above, the tender will be altered to the reduced amount by reducing these specific items.

PS 12 EMPLOYMENT OF LABOUR

PS 12.1 Interpretations

PS 12.1.1 Supporting documents

The Tendered Rules, Conditions of Contract, Standard, Supplementary and Specific Specifications and Construction Specifications and drawings shall inter alia be read in conjunction with this specification.

PS 12.2 Application

The provisions of this specification shall apply in respect of all workers and small, medium and micro enterprises other than the Contractor's key personnel, who are engaged on the execution of the works.

PS 12.3 Community Liaison Officer

The Project Steering Committee will identify a Community Liaison Officer (CLO) to act as a liaison between the Contractor and the community. The CLO will, amongst other things, ensure that the employment of local labour proceeds smoothly.

All decisions regarding identification and hiring of labour, relieving labour of their duties, local problems and any other matters of local importance related to the Contract, will be made in consultation with the CLO.

PS 12.4 Appointment, Office and Replacement of CLO

The CLO will be appointed for the duration of the construction phase of this Contract.

The CLO will occupy his own office in the Contractor's camp from where he will fulfil his duties to identify, screen and nominate labour from the community in accordance with the Contractor's requirements.

The CLO will communicate with the Contractor daily regarding labour requirements.

Should it become apparent that the appointed CLO fails to meet his duties, he may be relieved from his duties and replaced by a new CLO in consultation and approval with the Employer's Agent.

PS 12.5 Duties of the CLO

- They will be available on site daily between the hours of 07:30 and 18:30, and at other times as the need arises.
- They will consult with the Contractor and the Employer's Agent daily to determine the labour requirements regarding number and skills, to identify possible labour disputes, and to inform local labourers timeously when they will be relieved.
- They will be responsible for screening of candidates, informing them of their conditions of temporary employment and to ensuring their timeous availability.
- They will ensure that all workers who are involved in activities where productivity rates have been agreed, are fully informed regarding the expected level of productivity for the given tasks to be assigned as part of this Contract.
- They will attend disciplinary proceedings to ascertain that hearings are fair and reasonable.
- In consultation with the Contractor, They will determine the needs of the local labour for relevant technical training, and will be responsible for the identification of suitable trainees. They will also be required to attend some of the training sessions.

- They will keep a daily written record of his interviews and community liaison.
- They will attend the monthly Contractual site meetings to report about the local community labour involvement as well as any other relevant issues that need attention.
- They will act as a liaison officer between the Contractors on site and the local community through the project committee.
- They will be involved in all SMME related matters (Contracts, terminations etc.)

PS 12.6 Scheduled Item

PS.12.6.1a Community Liaison Officers **Unit: Provisional Sum**

The tendered sum shall include full compensation for the provisions of the CLO including salary (market related), provision of an office, transport costs, the cost of typing, printing and distributing notices, and for all other obligations to perform their job.

PORTION 2: VARIATIONS & ADDITIONS TO THE STANDARDISED SPECIFICATIONS

SANS 1200A: CIVIL ENGINEERING CONSTRUCTION: PRELIMINARY AND GENERAL

This portion of the specification covers variations and additions to the SANS 1200 Standardised Specifications. The clause numbers hereunder consist of a prefix, such as "PSA" indicating an amendment to SANS 1200 A and a number that represents the number of the clause in SANS 1200.

PSA 3 MATERIALS

PSA 3.3 Materials Supplied by Others

Where materials are supplied by others, the Contractor shall take delivery of such materials on site and shall be responsible for the safekeeping of the same from the time of taking delivery to the time of building into the Works or the time of return to the supplier. The Contractor shall return to the supplier any materials not used on the Contract.

PSA 3.4 Name Boards

The numbers of name boards noted in the Bill of Quantities are to be provided under this contract.

No other name boards other than stated above shall be allowed. The Contractor shall erect the name boards at locations indicated by the while establishing himself on Site, but not later than 14 days after the start of the Contract.

The name boards shall comply with the requirements as stipulated by the Employer's Agent.

On completion of the works, the Contractor shall obliterate all particulars on the name board and remove the board from the site, prior to the release of retention money.

PSA 3.5 Site Office

Replace this Sub-Clause with the following:

PSA 3.5.1 Specification for Office & Meeting Room Furniture

In addition to the furniture supplied by the Employer, the following items shall be provided under this Contract:

a. One (1) office desk each with a surface area of at least 1.5m² with lockable drawers with keys.

b. One (1) drawing rack for A0 drawings. The hangers shall be of the "Barhold" type with ten hangers per drawing rack.

c. One (1) drawing table with an inclined surface area of at least 3m² and a smooth top constructed to the dimensions as directed by the Employer's Agent's Representative.

d. Two (2) sturdy and comfortable chairs fitted with padded seats and backrests.

e. Venetian blinds or roller blinds, opaque type fitted to all the Employer's Agent's offices.

f. One (1) large meeting table to accommodate approximately 15 people.

g. Fifteen (15) plastic chairs with metal frames; and

h. One (1) plastic rubbish bin.

i. Laptop with the following minimum specifications: Core I5-1135G7 processor, 8 Gig DDR4 RAM, 500GB SSD hard drive, 19.5 inch external monitor, security cable, carry case, mouse and Windows 10 operating system, Microsoft Office Business Suite 2019 and 20 Gigs of Data.

j. Software – One (1) Microsoft Office Business Suite 2010 (Word, Excel, Outlook, Powerpoint), One (1) Autocad 2021, One (1) Civil 3d 2021, three (3) MS Project 2010 and Four (4) Voloview (drawing viewer).

PSA 3.5.2 Employer's Agent's Meeting Room and Employer's Office

The Contractor shall provide one prefabricated site meeting room and one office similar to the existing meeting room and offices of approved dimensions with at least 35m² in floor area for the meeting room and 18m² in floor area for the Employer's Office. The rooms shall be completed, furnished and ready for use not later than three weeks after the commencement date of the Contract.

The timber floor of the office shall be at least 300mm above the surrounding ground level. Doors shall be provided at each end of the meeting room and each shall be provided with a suitable 3 lever lock and two keys.

Windows shall be provided, with a minimum glazed area of 15% of the floor area. At least half of this area must be able to open and shall be fitted with burglar bars and all the windows shall be fitted with venetian or other approved blinds.

The meeting room will be equipped with furniture supplied under PSAB 3.2.1.

Two (2) air conditioning units shall be supplied with the meeting room with capacity for the air volume of the room as per PSAB 3.2.6 and one (1) air conditioning unit shall be supplied for the Employer's Office.

Adequate electric fluorescent lighting and four (4) 15-amp power points.

PSA 3.5.3 Car Ports

Carports shall be so constructed as to protect the vehicles parked under them at all times against rain, hail and sun. Shade netting will not be permitted for the carports. Preference is for corrugated iron sheeting for the roof and sides. The carports shall each be at least 15 m² in area and their floors shall consist

of a layer of broken stone or concrete to minimise dusty and muddy conditions. Seven car ports are required.

PSA 3.5.4 Areas Surrounding Offices

The access and other roads and parking areas surrounding the existing offices shall be treated and maintained to make them dust free either by using crushed stone or bituminous surfacing. They shall be well drained and kept trafficable and free from mud and weeds at all times. They shall also be maintained and kept clean and tidy at all times.

PSA 3.5.5 Air-conditioning Units and Heaters

The Contractor shall provide and install air-conditioning units and heaters as specified. The air-conditioning units shall be electrically operated compressor type with closed circuit, and not an evaporation type. The capacity of the air-conditioning units shall be at least 2,2 kW. The heaters shall preferably be of the space-heating type without exposed elements and shall have a capacity of not less than 1,5 kW.

PSA 3.5.6 Ablution units

Ablution facilities for the sole use of the Employer's Agent's staff and visitors must be provided.

PSA 3.6 Services

PSA 3.6.1 Sanitary arrangements

The Contractor shall be responsible for providing all sanitary services on the site.

The Contractor shall also make provision for the removal of all domestic rubbish on a regular basis.

PSA 3.6.2 Water and Electricity

The Contractor shall provide a constant supply of clean potable water suitable for human consumption.

The cost of all water & electricity required for the Employer's Agent's purposes shall be borne by the Contractor. All buildings supplied shall include the provision of 220 V electricity.

PSA 3.6.3 Maintenance

The Contractor shall provide all labour, equipment and material which may be necessary to keep all accommodation in a neat and clean condition, and repairs shall be done without undue delay.

PSA 3.7 General

a. The Contractor shall not order any materials, equipment or fittings on the basis of their having been specified or scheduled without the written confirmation of the Employer's Agent having been obtained. No building shall be erected without the Employer's Agent's written instructions as to the exact position and orientation of the building.

b. Unless otherwise agreed upon, the meeting room shall be erected in close proximity to the Employer's Agent's offices.

c. The required facilities shall be completed, ready for occupation as specified, not later than three (3) weeks after the commencement date of the contract.

d. The ownership of the meeting room and Employer's Office shall remain the property of the Employer at the end of the Contract.

e. The ownership of the furniture in PSAB 3.2.1 and PSAB 3.2.3 shall remain the property of the Employer.

f. The Contractor shall take all reasonable precautions to prevent unauthorised entry to the offices and to ensure the general security of the offices and meeting rooms.

g. No accommodation shall be erected without the prior approval of the Drawings by all local or Government authorities requiring such prior approval.

PSA 4 PLANT

PSA 4.2 Contractor's Offices, Stores and Services

Add the following:

The Contractor shall make the necessary arrangements with the relevant authority for the provision of services such as telephone and water for domestic and/or construction purposes.

The electrical wiring of all buildings shall be carried out by registered and licensed electricians in accordance with the requirements of SANS 0142 and the regulations of the local authority.

The Contractor shall not be obliged to make use of local water and electricity services and shall be at liberty to obtain them from approved alternative sources.

Should the Contractor make use of local services, he shall make arrangements, where applicable, for connections to be made, complete with meters, from these services for use at the Site. All costs incurred in respect of these connections and the meters, pipes, cables, etc. from the connections to his facilities, the cost of the water consumed, the cost of the removal of sewage (not chemical toilets), and the cost for finally disconnecting and removing the services shall be paid by the Contractor, who shall include full compensation for such costs in his tendered rates for the various items of work requiring the use of one or more of the services. The Contractor shall furnish the Employer's Agent with documentary proof that proper notice has been given to the relevant authority for termination of the services.

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

The Contractor under this Contract shall supply his own distribution board for distributing the power to his facilities. He shall be responsible for distribution of power and water supply to other mechanical and electrical Contractors on the Site. Payment for these services to other Contractors shall be arranged between the Contractor under this Contract and the other Contractors. The Employer will not be involved in any arrangements in this regard.

The Contractor shall deliver to the Employer's Agent a detailed drawing of the proposed layout of his offices, stores and services before erecting same.

Sufficient backup services shall be provided to ensure the uninterrupted execution of the Works such as storage tanks for water for use in the mixing of concrete, standby electrical power for work at night and for electrical plant and equipment used on Site.

PSA 4.3 Plant and Equipment

Add the following to this sub-clause:

The Contractor is required to provide all plant and materials necessary to carry out the works as required. No additional allowances other than those already specified in the Bill of Quantities shall be allowed for with respect to plant and materials.

Add the following to this sub-clause:

The Contractor is required to provide all equipment necessary to carry out the works as required. No additional allowances other than those already specified in the Bill of Quantities shall be allowed for with respect to equipment.

Construction equipment shall be suited for the onsite intended use and shall comply with all relevant safety aspects required by the OHS Act.

PSA 5 CONSTRUCTION

PSA 5.1 Survey

PSA 5.1.1 Setting Out of The Works

Delete this sub-clause and replace with the following:

The Contractor shall set out the works and maintain their correct position, not only according to the Contract Documents but also according to any drawings or orders that he may receive from time to time from the Employer's Agent. The Contractor shall:

a. be held responsible for the accuracy of the setting out for the full period of the Contract.

b. use equipment and instruments that can ensure the necessary accuracy.

c. be held responsible for the correction of any error at his own expense and

d. update the plans, which are kept on site so that all the changes approved by the Employer's Agent are reflected on the drawings. These drawings will represent record drawings and must consequently reflect the Works as they are actually built. The cost for this shall be deemed to have been included in all works construction rates. The Contractor must check drawings periodically and after completion of the Contract they shall be handed over to the Employer's Agent.

e. confirm the levels and coordinates of all benchmarks prior to commencing with construction.

Add the following to this sub-clause:

PSA 5.1.3 Alterations, Additions, Extensions and Modifications to Existing Works

The Contractor is required to verify the accuracy of all drawings and levels provided by the Employer's Agent prior to commencing with any construction activities.

Where the Works require that alterations, additions, extensions and / or modifications be carried out to existing works or facilities, these shall be carried out strictly in accordance with the requirements of the relevant authorities.

PSA 5.2 Watching, Barricading, Lighting and Traffic Crossings

Replace the words "traffic crossings" in the heading and in text of this sub-clause with the words "accommodation of traffic"

Add the following:

PSA 5.2.1 General Accommodation of Traffic

The Contractor shall be responsible for the safe and easy passage of vehicular and pedestrian traffic over, past or alongside the works.

PSA 5.2.2 Traffic control

Wherever the Contractor's activities on site affect or have the potential to affect the normal flow or safety of traffic during the construction, he shall be responsible for all aspects of traffic control, including flagmen, warning devices, signs, channelisation devices, layout of detours and by-passes, sign sequences and layouts, and all the requirements of the Chief Traffic Officer of the Local Authority.

Only warning devices, signs and channelisation devices included in the latest Road Traffic Ordinance of the province concerned (hereinafter referred to in this clause as the "Ordinance") shall be used. The standard patterns of the traffic control devices and signs, and the traffic-control procedures and methods prescribed in the Ordinance shall be applied. The dimensions and other properties of all signs and devices and the sign and device sequences, layouts and spacing shall be in accordance with the provisions of the Ordinance unless otherwise specified. In addition, signs and devices shall be placed at the positions shown on the Drawings. In cases not covered by the Ordinance, the signs, speed limits, devices, sequences, layouts and spacing shall comply

with the requirements of The South African Road Traffic Signs Manual, the Chief Traffic Officer of the relevant authority, and the Employer's Agent.

The Contractor shall ensure the safe accommodation of traffic at all areas where the Works may impact on traffic, and shall provide all drums, watching, lighting, signs and barricades required by the road authorities, and in accordance with the South African Road Traffic Signs Manual. In this regard, the following references have been extracted from the SARTSM Volume 2, Chapter 13:

Item	**Page No.**
General	13.10.1
Urban Roadworks	13.10.1
Temporary Traffic Signals	13.10.2
Sidewalk Deviation	13.10.4
Localised Work Site – Good Visibility	13.10.6
Lane Closed Beyond a Junction	13.10.8
Work within a Junction	13.10.10
Work in a One-way Street	13.10.12
Road Closure - CBD	13.10.14
Road Closure – Dual Carriageway Street	13.10.16
Road Closure - Detour	13.10.18
Freeway/Dual Carriageway: Lane Closure	13.11.3

Where applicable, the Contractor shall be responsible for traffic-control at night and adequate warning lights and flashing lights shall be provided.

PSA 5.3 Protection of Structures

Add the following:

PSA 5.3.1 Inspection of Adjoining Properties

The Contractor shall carry out inspections and evidence collection, as he deems appropriate, of properties adjoining the works to ensure that, in the event of a claim arising from any of the owners of the adjoining properties for damage to property and the like, the Contractor has substantial evidence to support or refute such claims. The Contractor accepts full liability and responsibility for damage that he causes to adjoining properties as well as any costs involved in refuting or processing of such claims.

PSA 5.4 Protection of Overhead and Underground Services

Add the following:

Timely written notice shall be given by the Contractor to the Employer's Agent and to the authority or department concerned of the Contractor's intention to work across or near any existing works or services and such work shall not commence until the necessary permission has been received. The Contractor will not be entitled to claim for any delay in the construction programme caused by compliance with the requirements of this clause. Work across or near any existing works or services shall be carried out in compliance with the requirements of the relevant authority or department.

Whilst every effort will be made to ensure that any information relating to underground services is correct, the Employer and Employer's Agent takes no responsibility for the accuracy, or for the completeness of the information. The Contractor will be held responsible for any damage to services and shall be liable for the cost of making good the damage. All such costs incurred by the Employer will be deducted from monies due to the Contractor.

Manhole covers; valve boxes, hydrants, etc. shall not be covered over and shall be accessible at all times.

After an existing service has been passed in laying the service pipe, but before backfilling has been started, the Employer's Agent or relevant authority shall be informed in order that they may certify in writing that the service has not been damaged.

Add the following:

PSA 5.4.1 Permits and Way leaves

The Contractor will be required to obtain permits from all the applicable service providers within the jurisdiction of the City of Johannesburg. It is the Contractors responsibility to obtain final permit approval according to applicable procedures and specifications. Permits and associated costs shall be deemed to have been included in the schedule rates for Way leaves and Permits.

Add the following:

PSA 5.4.2 Responsibilities

The Contractor:

a. Shall make provision for the possible existence of numerous services (e.g.: Stormwater, Water, Sewers, Eskom, City Power, Egoli Gas, Sasol Gas, Rand Water, Telkom, and the like) within and in close proximity to the work areas.

b. Shall obtain way leaves indicating the location of existing services from all affected service providers prior to the commencement of construction. The Contractor is to comply with the conditions of the way leaves received from the various service providers.

c. Shall ensure the protection and integrity of all existing services exposed and encountered through the course of construction activities. Adequacy in terms of protection of existing services shall be at the

discretion of the Employer's Agent. The Contractor is to make good the protection of and any breakages to existing services. The Contractor is to record on the As-Built drawings the location of existing services or services which have been relocated during the Contract Period.

d. Shall inform the relevant service provider immediately (within 2 hours of the incident) such that procedures for the reinstatement of the service can be effected, should he damage or break an existing service (whether known or unknown).

e. Is responsible to provide their own equipment in order to determine the location of existing services.

Add the following:

PSA 5.4.3 Locating Existing Services

Existing known services, both underground and overhead, are indicated on the drawings, but the positions of existing services on the drawings are not guaranteed nor does the Employer, nor the Employer's Agent, accept any liability in this regard. The Contractor shall liaise with all relevant local authorities to satisfy himself that all relevant services have been located.

At the commencement of the Contract, the Contractor shall hand excavate a distance 0.5 m on each side of the located service to expose it. The exposed service shall be identified and recorded on a drawing.

A copy of the drawing with all known services shall be submitted to the Employer's Agent before construction can commence in any road reserve.

Once the exposed service is identified and recorded the excavation shall immediately be backfilled. Re-excavation by hand at construction stage will not be measured in addition to normal trench excavation.

The Contractor shall retain full responsibility for establishing the exact positions of the various services in advance of any construction work. No allowance for

delays or disruption shall be entertained unless the Contractor complies fully with the provisions of this clause regarding the establishment of the exact positions of the various services in advance of any construction work

PSA 5.5 Dealing with Water

Add the following paragraph:

"The Contractor shall be deemed to have acquainted himself during tender stage with the groundwater and surface water conditions."

PSA 5.6 Pollution

Add the following:

Precaution against Pollution and Nuisance

The Contractor's attention is drawn to the fact that operations will be conducted in urban areas and in the presence of passing traffic. The Contractor shall take all necessary steps and precautions to prevent pollution of the surrounding area by his employees in any way.

Wherever excavated and/or loaded material is liable to form a dust nuisance, an effective method of spraying water over the cut area and loaded material shall be installed. Tarpaulins shall be provided to cover trucks and prevent dust blowing from loads during transport.

Any material or debris falling from trucks on the roads in use by the public shall be immediately removed. Precautions shall be taken to prevent fouling of public roads or completed construction by trucks transporting muddy material. The Employer's Agent may order the Contractor to continuously broom off and clean where the mud tracking of vehicle or falling debris may constitute a danger to the public making use of roads.

PSA 5.7 SAFETY

Add the following:

1. The Contractor shall at all times observe adequate safety precautions on Site to ensure the safety of his own staff as well as that of the public and other persons engaged in or about the Works. In this respect he shall observe all laws, ordinances and regulations pertaining to his work.

2. The Contractor's attention is specifically drawn to the following Acts, and particularly to the relevant regulations under each Act, copies of which shall at all times be kept by him on the Site:

   - The Factories, Machinery and Building Work Act (Act 22 of 1941)

   - The Explosives Act (Act 26 of 1956)

   - The Mines and Works Act (Act 27 of 1956)

   - The Occupational Health and Safety Act (Act 85 of 1993)

3. The Contractor is also required to comply with the safety precautions set out in the following publications, copies of which shall also be kept by him on the Site:

   - The Code of Practice relating to the safety of men working in civil Engineering inspection pits and small diameter vertical shafts. (Transactions of the South African Institution of Civil Engineers, Vol. 2, No. 11, November 1960, obtainable from the Secretary, S.A. Institution of Civil Engineers, Private Bag X200, Halfway House, 1685).

   - The Operator's Handbook on Sewage Purification (1965) Chapter 26. Safety Precautions published by the Institute of Water Pollution Control (Southern African Branch).

4. The Contractor shall provide suitable and safe access by way of ladders, gangways, etc. to all parts of the Works as may be required for construction purposes or for inspection by the Employer's Agent or the authorised Inspectors in terms of the above-mentioned Acts.

5. All precautions shall be taken to protect workmen against falling material and/or objects and other dangers whilst they are carrying out their duties. Shaft and trenches shall in every way be made and kept safe for persons working therein.

6. All persons working, inspecting or supervising in places where falling material and/or objects could be encountered shall be provided by the Contractor with hard hats of a type approved by the Inspector of Mines, the use of which shall be strictly enforced.

7. The Contractor shall provide a properly equipped first aid box, which shall be accessible at all times.

8. Where adequate safety precautions are not being observed, the Employer's Agent may order the Contractor to comply with minimum safety requirements at the latter's expense. Compliance with such order will not absolve the Contractor from any of his responsibilities and obligations under the Contract.

9. The Contractor shall display on a prominent place the following emergency information:

   - **Local Police:** Telephone number
   - **Local Ambulance:** Telephone number
   - **Local Fire Brigade:** Telephone number
   - **Nearest Doctor:** Name

     Telephone number (office hours)

     Telephone number (after hours)

     Consulting room street address

PSA 8 MEASUREMENT AND PAYMENT

PSA 8.1.2.3 Contractor to Price all Items

Add the following paragraph;

"The grouping of payment items under one all-inclusive rate is prohibited. Each payment item shall have its own rate. Where the Contractor elects not to insert a rate for any particular item, then it shall be deemed to be zero".

PSA 8.2 Payment

PSA 8.2.2 Time-related Items

In the event that the net total extension of time granted in terms of the Contract and/or delay in the anticipated date of award of the Contract results in the official date for completion extending into or past a Christmas Builders Holiday period which did not fall within the tendered period for completion based on the anticipated date of award, and extension of time equivalent to the number of normal working days falling within that holiday period shall reduce to 25% of that applicable in terms of the above. It should be noted that time-related charges for the Christmas Builders Holiday period falling within the tendered period for completions based on the anticipated date of award of the Contract will be paid for at the full rate since such holidays are to be included in the tendered period for completion.

The anticipated date of award referred to above shall be the date stated in the Contract Documents. If the date is not stated it shall be considered to be any date within the period of validity of the Tender.

Delete the last four lines of this sub-clause, i.e. the paragraph commencing with the word "Note..."

PSA 8.3 Scheduled Fixed-Charged and Value-Related Items

PSA 8.3.1 Contractual Requirements

Add the following to this clause:

As indicated in the Contract Data (Clause 8.6.13), any claims against the insurance effected by the Employer shall be subject to the Contractor being responsible for the payment of the amount stated in the Policy as being the Deductible (First Amount Payable) as defined in the Policy.

PSA 8.3.2.1 Facilities for Employer's Agent

Add the following to this sub-clause:

d)	Latrine facilities	**Unit: Sum**
e)	Board room to accommodate 15 personnel	**Unit: Sum**
f)	Carports (5 of)	**Unit: No**
h)	Construction & setting out of survey beacons (3 No. of)	**Unit: Sum**
i)	Furniture for offices & meeting room	**Unit: Sum**

Furniture includes an office desk with 2 chairs, a drawing table to adequately accommodate A0 drawings, a boardroom table and chairs to accommodate 15 people, and a lockable filing cabinet,

j)	Laptop, Data & Software	**Unit: Sum**

Laptop Specification: I7-1255U, 16 inch G9, INTGRTD CAM DM 5MP IR LCD 16.0 WUXGA AG, LED250UWVAF5MPIRTOPBNT, RAM 16GB (2X8GB) DDR5 4800 SSD 512GB PCIE-4X4 NVME TLC NO NFC WLAN I, AX211 WI-FI 6E 160MHZ +BLUETOOTH 5.3 WW NO WWAN, Windows 11

Data Allowance: Minimum 10Gigabytes per month.

PSA 8.3.2.2 Facilities for the Contractor

(f) Tools and Equipment

Add the following new sub-clause:

"The sum shall cover the cost of supplying all hand tools and equipment, as necessary for proper execution of the works. **Unit: Sum**

Add the following new sub-clause:

(k) Security of works

"The sum shall cover the cost of supplying 24hr security at the Contractors camp as well as all other areas of the Works for the duration of the Contract. The cost should also include all other security requirements, as deemed necessary by the Contractor. Refer to clause PS7.2 . **Unit: Sum**

Add the following new sub-clause:

(l) Personal Protection Equipment

"The sum shall cover the cost of supplying all personal protective equipment, as deemed necessary by the Contractor and in accordance with the Health & Safety Plan. **Unit: Sum**

PSA 8.4 Scheduled Time Related Items

PSA 8.4.2.1 Facilities for Employer's Agent

Add the following to this sub-clause:

e) Latrine facilities for the sole of the Employer's Agent **Unit: Sum**

f) Boardroom to accommodate 15 personnel **Unit: Sum**

g) Carports (5 No. of) **Unit: No**

h) Construction & setting out of survey beacons (3 No. of) **Unit: Sum**

i) Furniture for offices and meeting rooms **Unit: Sum**

Furniture includes an office desk with 2 chairs, a drawing table to adequately accommodate A0 drawings, a boardroom table and chairs to accommodate 15 people, and a lockable filing cabinet,

j) Laptop, Data & Software **Unit: Sum**

Laptop Specification: I7-1255U, 16 inch G9, INTGRTD CAM DM 5MP IR LCD 16.0 WUXGA AG, LED250UWVAF5MPIRTOPBNT, RAM 16GB (2X8GB) DDR5 4800 SSD 512GB PCIE-4X4 NVME TLC NO NFC WLAN I, AX211 WI-FI 6E 160MHZ +BLUETOOTH 5.3 WW NO WWAN, Windows 11

Data Allowance: Minimum 10Gigabytes per month.

PSA 8.4.2.2 Facilities for the Contractor

Add the following new sub-clause:

k) Security of Works

"The sum shall cover the cost of supplying all security works, as deemed necessary by the Contractor, refer to clause PS7.1

Unit: Sum

l) Water Tanker for Dust Suppression

The rate shall include for the full-time supply and operation of a water tanker, with assistant to keep all the roads and work areas dust free for the duration of the contract. The rate shall include for the filling of the tanker from a designated water source. **Unit: Sum**

PSA 8.4.3 Supervision for the Duration of the Contract

Add the following to the Clause:

The sum stated shall include, at minimum, the cost of full time, on-site supervision in the form of a Site Agent and Contracts Manager; whose qualifications and level of experience meet the requirements stated in the Functionality Criteria (Volume 1, Part 1, Tender Procedures). Both resources will be expected to provide the full range of Project Management Services as they relate to the Works. **Unit: Sum**

PSA 8.4.4 Compliance with Local Content Requirements

The sum stated shall include, at minimum, the cost of all items required to ensure compliance with local content obligations. These may include (but are not limited to), packaging of works, sourcing, evaluation and negotiations, appointments, contracts, liaison with Ward councillor, CLO and JW Stakeholder Relations, etc. Additionally, the sum stated should include any additional items that the Contractor may deem necessary. **Unit: Sum**

PSA 8.5 Sums Stated Provisionally by Employer's Agent

(b) (3) Add the following sub-items:

a) Provisional sum for control testing to be carried out as required by the Employer's Agent, including testing of structure **Unit: Prov Sum**

b) Additional tests ordered by Employer's Agent **Unit: Prov Sum**

The provisional sum shall cover the cost of control tests specifically ordered by the Employer's Agent. Tests shall be executed by an approved commercial laboratory.

c) Community Liaison Officer **Unit: Prov Sum**

The provisional sum shall cover the cost of advertising, interviewing and employing the CLO. Additionally, it should include the CLO's salary for the duration of the Contract.

d) Training of targeted labour and SMME's

The sum shall be in full compensation for the provision of training to targeted labour according to the specification of the Employer and approved by the Employer's Agent. **Unit: Prov Sum**

e) Training of Interns

The sum shall be in full compensation for the provision of training of interns according to the specification of the Employer and approved by the Employer's Agent. **Unit: Prov Sum**

f) Signage for Buildings

The sum shall cover the full cost of the supply and installation of signage onsite. **Unit: Prov Sum**

g) GPR Survey

The sum shall cover the full cost of a GPR survey to identify all existing sub-surface services as directed by the Employer's Agent. The survey submission must include all drawings in DWG and PDF format. **Unit: Prov Sum**

h) Protection of Existing Services

The sum shall cover the full cost of protecting the identified existing services which may be exposed during the duration of the Contract. **Unit: Prov Sum**

i) Application for Environmental regulation

The sum shall cover the full cost for Environmental Regulation which may be required by the authorities during the duration of the Contract. **Unit: Prov Sum**

j) Environmental Control Officer

The sum shall cover the full cost of an Environmental Control Officer during the duration of the Contract. **Unit: Prov Sum**

k) Full time Environmental Liaison Officer

The sum shall cover the full cost of a Full time Environmental Liaison Officer during the duration of the Contract. **Unit: Prov Sum**

l) Project Mentor

The sum shall cover the full cost of a Project Mentor during the duration of the Contract. **Unit: Prov Sum**

m) Contractor's percentage to cover cost of handling cost and charges

PSA 8.7 Daywork

Replace this clause with the following:

PSA 8.7.1 Expenditure on Daywork Items

Wages paid to workmen and invoices of cost of materials delivered on site. **Unit: Prov Sum**

PSA 8.7.2 Supervision, Overheads and All Other Costs

Extra over item PSA 8.7.1 for supervision, overheads and all other costs related to the Daywork items under item PSA 8.7.1 for the following:

a) Skilled Labourers **Unit: Percentage of Prov Sum**

b) Unskilled Labourers **Unit: Percentage of Prov Sum**

c) Material **Unit: Percentage of Prov Sum**

PSA 8.7.3 Plant Hire Rates

Types and sizes indicated in the bill of quantities **Unit: hours**

a) Labour

The labour charges to be reimbursed under the Daywork item PSA 8.7.1 in the Schedule of Quantities shall be the actual amount of wages paid to workmen, chargehands and gangers, (but not foremen), employed on Daywork with the authorisation of the Employer's Agent. The labour charges will be paid only for the time that the workmen are actually employed on Daywork.

Leave pay, bonuses, subsistence allowances, employer's contributions to medical schemes and provident funds and the like shall not be included in the above-mentioned labour charges but will be deemed to be covered by the percentage rate tendered by the Contractor against the items PSA 8.7.2(a) and PSA 8.7.2(b) scheduled for this purpose under Daywork in the Schedule of Quantities.

This percentage rate shall also be deemed to allow for the use of small tools, supervision, insurances, overhead expenses, transport of workmen, housing and feeding (if the liability of the Contractor) profit and any other expenses in connection with workmen employed on Daywork and shall also include for everything else covered under the allowances as stated in Clause 6.5 of the GCC.

b) Materials

The material charges to be reimbursed under the Daywork item PSA 8.7.1 scheduled in the Schedule of Quantities shall be the invoiced cost as approved by the Employer's Agent, less any discount granted by the Supplier. Only the actual quantities of materials used, as verified by the Employer's Agent, will be paid for.

The cost of transportation to site, storage, transportation to the point of use on site, insurance, superintendence and administrative costs, overhead expenses

and profit shall be deemed to be covered by the percentage rate tendered by the Contractor against the item PSA 8.7.2(c) scheduled for this purpose under Daywork in the Schedule of Quantities. The percentage rate tendered shall also include for everything else covered under the allowances as stated in Clause 6.5 of the GCC.

c) Plant Hire Rates

The rates tendered for the hire of plant shall be applicable only to plant that the Contractor has on the site and shall be total all inclusive unit prices which shall include, inter alia, for all fuel and lubricants; for the wages of operators, drivers or attendants; for all tools, accessories, equipment and everything else necessary; for all depreciation, maintenance and repair costs; for overhead expenses, profit and for everything in accordance with Clause 6.5 of the GCC.

The hire charges shall be paid only for the time that the plant is actually working on the Daywork as authorised by the Employer's Agent.

Payment will not be made in respect of established, fixed or static plant on the site such as static concrete batching and mixing plant, cocopan track, monorails, static generators, compressors, pumps, lighting, ventilation plant and the like which are covered under other items but which may be used for Daywork.

PSA 8.8 Temporary Work

PSA 8.8.2 Dealing with Traffic and Maintaining of Existing Roadways

Tendered rate to include provision for dealing with traffic on Walton Road and Whisken Avenue during construction. Contractor to include all necessary provisions (including method statements and traffic accommodation drawings) for road closure traffic management during construction of the access road (including entrance).Road closures will only be allowed between 9am – 3pm Traffic calming and management mechanisms to include the use of signage, barricades, flagmen etc, as deemed necessary by the Contractor. **Unit: Sum**

PSA 8.8.4 Relocation of Services

Excavation for exposing existing services in the following depth ranges below ground level:

a. 0,0 m up to 2,0 m:

i. Soft material **Unit: cubic metre (m³)**

ii. Intermediate material **Unit: cubic metre (m³)**

iii. Hard material **Unit: cubic metre (m³)**

b. Exceeding 2,0 m up to 4,0 m:

i. Soft material **Unit: cubic metre (m³)**

ii. Intermediate material **Unit: cubic metre (m³)**

iii. Hard material **Unit: cubic metre (m³)**

c. Extra over sub-items (a) and (b) above for hand excavation by means of hand tools such as picks, crowbars and pneumatic tools in close vicinity of services or where no blasting or machine excavation is allowed:

i. Soft material **Unit: cubic metre (m³)**

ii. Intermediate material **Unit: cubic metre (m³)**

iii. Hard material **Unit: cubic metre (m³)**

The unit of measurement shall be in cubic metre of the material removed as specified.

The rates shall include full compensation for all cost to excavate and break down the various classes if materials, including the cost of all the necessary additional effort, plant, tools, materials, labour and supervision.

PSA 8.9 Work Stoppage

The rate tendered shall cover all unforeseen work stoppages which may be attributed to community disruptions, COVID-19 related delays etc, and will be assessed at the discretion of the Employer's Agent. Rate to be based on the Contractors total Time Related Preliminary & General items. **Unit: Days**

PSA 8.10 Sub-Contractors (SMME's)

PSA 8.10.1 Main Contractor Overhead Charges and Profits

The Main Contractor shall retain liability and responsibility for the management, scheduling, and quality control of all works performed by approved sub-contractors (SMME's). This item will be calculated as a percentage of the sum of works allocated to SMME's and shall include the process to appoint a sub-contractor, as well as all costs and charges to manage all sub-contracted works. (Note: This amount must be at a minimum of 30% of the total contract value).
Unit: Percentage of total amount of work done by SMME's (%)

PSA 8.10.2 Fixed Charge Items for SMME Contractual Requirements

This item will be calculated as a percentage of the approved amount towards Fixed Charged Preliminary and General Items allocated to SMME's as compensation for Overhead Charges and Profits for the Main Contractor.

Unit: Percentage of total amount of Fixed Charge Items for SMME's (%)

PSA 8.10.3 Time Related Items for SMME Contractual Requirements

This item will be calculated as a percentage of the approved amount towards Time Related Preliminary and General Items allocated to SMME's as compensation for Overhead Charges and Profits for the Main Contractor.

Unit: Percentage of total amount of Time Related Charges for SMME's (%)

PSA 8.10.4 Payments on behalf of Sub-Contractor by Main Contractor

Provisional Sum to cover costs incurred by the Contractor when making payments of behalf of the sub-contractor (ref Special Conditions) or to provide ad-hoc services on behalf of the sub-contractor. **Unit: Prov. Sum**

SANS 1200AB: EMPLOYER'S AGENT'S OFFICE

PSAB 1 SCOPE

Replace this Clause with the following:

This section covers the provision of accommodation for the Employer's Agent's resident staff. This accommodation shall include the necessary additional offices and furniture as well as the provision of all the services required. The Contractor will be required to supply a meeting room, an Employers office, a Employer's Agent's Representative's Office and five car ports.

All furniture supplied shall be new.

PSAB 3 MATERIALS

PSAB 3.1 Name Boards

The numbers of name boards noted in the Bill of Quantities are to be provided under this contract.

No other name boards other than stated above shall be allowed. The Contractor shall erect the name boards at locations indicated by the while establishing himself on Site, but not later than 14 days after the start of the Contract.

The name boards shall comply with the requirements as stipulated by the Employer's Agent.

On completion of the works, the Contractor shall obliterate all particulars on the name board and remove the board from the site, prior to the release of retention money.

PSAB 3.2 Site Office

Replace this Sub-Clause with the following:

PSAB 3.2.1 Specification for Office & Meeting Room Furniture

In addition to the furniture supplied by the Employer, the following items shall be provided under this Contract:

k. One (1) office desk each with a surface area of at least 1.5m² with lockable drawers with keys.

l. One (1) drawing rack for A0 drawings. The hangers shall be of the "Barhold" type with ten hangers per drawing rack.

m. One (1) drawing table with an inclined surface area of at least 3m² and a smooth top constructed to the dimensions as directed by the Employer's Agent's Representative.

n. Two (2) sturdy and comfortable chairs fitted with padded seats and backrests.

o. Venetian blinds or roller blinds, opaque type fitted to all the Employer's Agent's offices.

p. One (1) large meeting table to accommodate approximately 15 people.

q. Fifteen (15) plastic chairs with metal frames; and

r. One (1) plastic rubbish bin.

PSAB 3.2.2 Employer's Agent's Meeting Room and Employer's Office

The Contractor shall provide one prefabricated site meeting room and one office similar to the existing meeting room and offices of approved dimensions with at least 35m² in floor area for the meeting room and 18m² in floor area for

the Employer's Office. The rooms shall be completed, furnished and ready for use not later than three weeks after the commencement date of the Contract.

The timber floor of the office shall be at least 300mm above the surrounding ground level. Doors shall be provided at each end of the meeting room and each shall be provided with a suitable 3 lever lock and two keys.

Windows shall be provided, with a minimum glazed area of 15% of the floor area. At least half of this area must be able to open and shall be fitted with burglar bars and all the windows shall be fitted with venetian or other approved blinds.

The meeting room will be equipped with furniture supplied under PSAB 3.2.1.

Two (2) air conditioning units shall be supplied with the meeting room with capacity for the air volume of the room as per PSAB 3.2.6 and one (1) air conditioning unit shall be supplied for the Employer's Office.

Adequate electric fluorescent lighting and four (4) 15-amp power points.

PSAB 3.2.4 Car Ports

Carports shall be so constructed as to protect the vehicles parked under them at all times against rain, hail and sun. Shade netting will not be permitted for the carports. Preference is for corrugated iron sheeting for the roof and sides. The carports shall each be at least 15 m² in area and their floors shall consist of a layer of broken stone or concrete to minimise dusty and muddy conditions. Seven car ports are required.

PSAB 3.2.5 Areas Surrounding Offices

The access and other roads and parking areas surrounding the existing offices shall be treated and maintained to make them dust free either by using crushed stone or bituminous surfacing. They shall be well drained and kept trafficable and free from mud and weeds at all times. They shall also be maintained and kept clean and tidy at all times.

PSAB 3.2.6 Air-conditioning Units and Heaters

The Contractor shall provide and install air-conditioning units and heaters as specified. The air-conditioning units shall be electrically operated compressor type with closed circuit, and not an evaporation type. The capacity of the air-conditioning units shall be at least 2,2 kW. The heaters shall preferably be of the space-heating type without exposed elements and shall have a capacity of not less than 1,5 kW.

PSAB 3.2.7 Ablution units

Ablution facilities for the sole use of the Employer's Agent's staff and visitors must be provided.

PSAB 3.3 Services

PSAB 3.3.1 Sanitary arrangements

The Contractor shall be responsible for providing all sanitary services on the site.

The Contractor shall also make provision for the removal of all domestic rubbish on a regular basis.

PSAB 3.3.2 Water and Electricity

The Contractor shall provide a constant supply of clean potable water suitable for human consumption.

The cost of all water & electricity required for the Employer's Agent's purposes shall be borne by the Contractor. All buildings supplied shall include the provision of 220 V electricity.

PSAB 3.3.3 Maintenance

The Contractor shall provide all labour, equipment and material which may be necessary to keep all accommodation in a neat and clean condition, and repairs shall be done without undue delay.

PSAB 3.4 General

h. The Contractor shall not order any materials, equipment or fittings on the basis of their having been specified or scheduled without the written confirmation of the Employer's Agent having been obtained. No building shall be erected without the Employer's Agent's written instructions as to the exact position and orientation of the building.

i. Unless otherwise agreed upon, the meeting room shall be erected in close proximity to the Employer's Agent's offices.

j. The required facilities shall be completed, ready for occupation as specified, not later than three (3) weeks after the commencement date of the contract.

k. The ownership of the meeting room and Employer's Office shall remain the property of the Employer at the end of the Contract.

l. The ownership of the furniture in PSAB 3.2.1 and PSAB 3.2.3 shall remain the property of the Employer.

m. The Contractor shall take all reasonable precautions to prevent unauthorised entry to the offices and to ensure the general security of the offices and meeting rooms.

n. No accommodation shall be erected without the prior approval of the Drawings by all local or Government authorities requiring such prior approval.

PSAB 3.5 Insurance

The Contractor shall keep all the site offices, furniture and equipment insured against loss, damage or breakage and shall indemnify the Employer, the Employer's Agent and his staff against claims in this regard for the full duration of the Contract.

SANS 1200 C: 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 site clearance."

PSC 5 CONSTRUCTION

PSC 5.1 Areas to be Cleared and Grubbed

Add the following:

"Pipeline routes shall be cleared on instruction of the Employer's Agent to a distance of 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

Preservation of Trees

PSC 5.2.3.2 Individual Trees

Replace the last sentence with the following:

"An amount of R1 000,00 will be deducted from moneys due to the Contractor as a penalty for every tree that is damaged or removed unnecessarily and without prior instruction from the Employer's Agent."

PSC 5.5 Re-clearing of Vegetation

Add the following:

"When areas have to be re-cleared on the written instructions of the Employer's Agent, such re-clearing shall be carried out at the Contractor's own cost and the Contractor is therefore advised not to clear the areas too soon."

SANS 1200 D: EARTHWORKS

PSD 3.2 Classification for Placing Purposes

PSD 3.2.3 Material Suitable for Backfill or Fill Against Structures

This clause is deleted and replaced by:

Areas against structures which may be damaged by the use of heavy equipment (e.g. grader, towed grid roller, large self-propelled vibratory roller, etc.) must get filled in layers with material from the excavations on the site which shall comply with clause 3.2.1 except that it shall contain more than 20% material passing the 75 micron sieve.

PSD 3.3 Selection

PSD 3.3.1 General

Add the following:

The Contractor will be required to stockpile the surplus excavated material on sites to be designated on the drawings or by the Employer's Agent.

The Contractor shall be entirely responsible for the selection of suitable material for all backfilling and embankments from excavation on the site and from borrow pits.

PSD 5 Construction

PSD 5.1.1 Safety

PSD 5.1.3 Stormwater and Groundwater

Add the following to this Sub-Clause:

Over and above his general obligations in regard to dealing with water as specified in SANS 1200 A, the Contractor shall be responsible for preventing the ingress of water into the foundation excavations. The preventive measures shall include the construction of proper drainage channels, diversion channels, berms, sumps, and the supply, operation and maintenance of the necessary bailing and pumping equipment if required.

The dewatering measures, with the exception of pumping, shall be maintained until the backfilling has been completed, after which all settled silt, mud, etc. shall be removed from the exposed surfaces where necessary. Between the various construction stages, pumping may be interrupted as may be decided by the Employer's Agent. The draining or pumping of water from foundation excavations shall be so done that no concrete materials will be carried away.

PSD 5.2.2 Excavation

Add the following Sub Clauses:

PSD 5.2.2.4 Utilization of Excavated Material

Excavated material and material recovered from temporary work shall, in so far as it is suitable, be utilized for backfill. Material unsuitable for use as backfill or in excess of the quantity required to complete the backfill shall be spoiled or utilized as directed by the Employer's Agent.

PSD 5.2.2.5 Excavation limits for payment purposes

For measurement and payment purposes, the limits of the excavations for structures shall be as shown on the Drawings.

Where no excavation limits are shown on the Drawings and the Employer's Agent has decided that formwork has to be provided for the sides of a concrete member, the limits of the excavation for measurement and payment purposes shall be the vertical planes 0.5 m outside the perimeter of the concrete member for which the formwork is to be provided, and the founding level shown on the Drawings.

PSD 5.2.2.6 Unsuitable Material

Boulders, logs or any other unsuitable excavated material shall be taken to spoil.

Where, in the opinion of the Employer's Agent, unsuitable material is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with the requirements of clause PSD 5.2.3.4 of this section and as directed by the Employer's Agent.

PSD 5.2.2.7 Preparation of the Founding Surface

Where hard material suitable for founding is encountered at the founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as may be required.

Where there are indications that the material at the founding level will be soft material or hard material that will deteriorate rapidly on exposure, the excavation of the final layer with a thickness of 150 mm shall be postponed until just before the blinding layer is placed.

Where shown on the Drawings or ordered by the Employer's Agent, excavations shall be extended to a specified depth below the given undersides of the slabs and footings to make provision for the placing of a concrete blinding layer.

PSD 5.2.3.3 Backfill and Fill Near Structures

a. General

When placing backfill and fill, the following precautions shall be taken:

i. In so far as it is possible, the material shall be placed simultaneously to approximately the same elevation on both sides of a structure or structural member where appropriate. If conditions require that backfill or fill be placed appreciably higher on one side than on the opposite side, the additional material on the higher side shall not be place until authorized by the Employer's Agent and preferably not until the concrete has been in place for 14 days, or until tests show that the concrete has attained sufficient strength to withstand any pressure safely that has been created by the backfill or fill or by the method of construction.

ii. The material behind structural members restrained at the top by the superstructure, e.g. portal type structures, shall be placed as stated on the Drawings or as directed by the Employer's Agent.

b. Backfill

Excavated areas around structures, between the structure and the vertical walls of the surrounding excavation, shall be backfilled with approved material in horizontal layers not exceeding 150 mm in depth after compaction, to the level of the original ground surface or to the level specified on the Drawings. Each layer shall be moistened or dried to the optimum moisture content for the material and be compacted to a density of not less than 93 % of modified AASHTO density, except that, in a road prism, the material shall be compacted to a density of not less than 93 % of modified AASHTO density. In cases where structures are founded on backfill material, the density shall be as specified in the Project Specifications but shall not be less than 95 % of modified AASHTO density.

c. Prevention of Wedge Action

Before the fill in the space between a structure and any adjacent sloping fill and the backfill between a structure and the sloping sides of the surrounding excavation is constructed, the slope of the fill and of the sides of the excavation shall be benched or serrated in order to prevent wedge action between the structure and the fill or the sides of the excavation during backfilling and compaction.

The distance between the exposed face of the structure and the toe of the fill or excavation side shall be sufficient to allow proper compaction.

PSD 5.2.3.4 Foundation fill

If, during the course of excavation, it is found that the material at the indicated founding depth does not have the required bearing capacity as specified on the Drawings, the excavations shall be extended at the discretion of the Employer's Agent until satisfactory founding material is encountered. The Employer's Agent reserves the right to order the Contractor to make up the difference in levels with foundation fill.

Where the foundation fill consists of rock or crushed stone, it shall be constructed as directed by the Employer's Agent.

Foundation fill consisting of granular material shall be constructed in layers not exceeding 150 mm in thickness after compaction. Each layer shall be moistened or dried to optimum moisture content for the material and be compacted to a density of not less than 95 % of modified AASHTO density.

Mass concrete fill to be used shall be of the class or mix specified or directed by the Employer's Agent.

PSD 5.2.4.2 Topsoiling

Delete this Sub-Clause and refer to Section PSVA.

PSD 5.2.4.3 Grass or Other Vegetation

Delete this Sub-Clause and refer to Section PSVA.

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.3.2 Bulk Excavation

b. Extra over for: Delete pay items (3) and (4).

PSD 8.3.3 Restricted Excavation

a. Excavation for restricted foundations, footings and pipe trenches in all materials and use for backfill or embankment or dispose

Add the following to this pay item

i. In the case of structures, excavation will be scheduled to different depths as follows:

a. 0 m up to 2 m **Unit: Cubic metre (m^3)**

b. Exceeding 2 m up to 4 m **Unit: Cubic metre (m^3)**

c. Etc. in increments of 2 m depths **Unit: Cubic metre (m^3)**

(ii) Extra over item (i) above for additional excavation required by the Employer's Agent after the excavation has been completed

Unit: Cubic metre (m^3)

The limits for the successive depth ranges shall be measured down from the average surface to the agreed founding level.

The unit of measurement shall be the cubic metre of material measured in the original position before excavation. The quantity of excavation for each depth range shall be calculated from the nett outlines of the excavation limits shown on the Drawings and the depth of excavation completed within each range.

Irrespective of the total depth of the excavation, the quantity of material within each depth range shall be measured and paid for separately.

Where no excavation limits are shown on the Drawings and formwork has to be provided to the sides of concrete members, an additional quantity of excavation shall be measured to 0,5 m outside the concrete perimeter in order to provide a working space.

Where foundation fill is constructed in an excavation, the quantity of excavated material measured for payment shall be the material excavated between the average ground surface, and the founding level, from the prism with vertical sides or as specified or directed by the Employer's Agent.

In no case shall any of the following volumes of excavation be included in the measurement for payment:

i. The volume of excavation in excess of the abovementioned limits.

ii. The volume included within the excavated road prism, contiguous channels, ditches, etc. for which payment is provided elsewhere in the Specifications.

iii. The volume of water or other liquid (except the volume of mud, muck or similar semi solid matter, which has not resulted from the construction operations and which cannot be pumped or drained away).

iv. Sloping sides of excavations required to make the excavation safe.

The tendered rate shall include full compensation for excavation in each class of material, including overbreak in hard material, the spoiling or stockpiling of material, the hauling of excavated material within the defined Site boundaries, for any additional excavation the Contractor may require for additional working space outside the authorized limits, for trimming and cleaning the bottoms and sides of excavation, and for strutting, shoring and safeguarding excavations.

If, after a foundation excavation has been completed, cleaned and trimmed ready for blinding, the Employer's Agent orders further excavations on account of changed dimensions and/or founding conditions, an extra over payment (item PSD 8.3.3(a)(ii) for the additional excavation shall be payable in full compensation for any additional costs to the Contractor over and above the normal excavation costs.

PSD 8.3.3(b) Extra-over for:

Delete pay items (3) and (4).

PSD 8.3.5 Extra Excavation in All Materials to Provide Working Space Around Structures

Delete this Sub-Clause and refer to Sub-Clause PSD 5.2.2.5.

PSD 8.3.10 Grassing or other vegetation cover

Delete this clause and refer to section PSVA.

SANS 1200 DB: EARTHWORKS (Pipe trenches)

PSDB 5 CONSTRUCTION

PSDB 4.3 Compaction Equipment

Add the following to this Sub-Clause:

A minimum thickness of compacted selected fill blanket of 300mm is required over the top of any pipe before machine compaction commences.

PSDB 5.1 Precautions

PSDB 5.1.1 General

Add the following to this sub-clause:

The Contractor shall programme his activities in such a way that long sections of trenches do not lie open for undue periods of time, as this poses a safety

risk. The pipes shall be laid as soon as possible after excavation of the trenches and the trenches then backfilled. Under no circumstances will trenches be left open for more than 1 week.

The Contractor shall inform the Johannesburg Road Agency (JRA) at least 2 days in advance of the actual date on which he proposes to excavate in any road or footway.

PSDB 5.1.3 Accommodation of Traffic and Access to Property

Add the following Sub-Clause:

All traffic signs and traffic control measures shall comply with the South African Road Traffic Sign Manual and the Road Signs Note.

PSDB 5.1.4 Existing Services That Intersect or Adjoin Trenches

Add the following to this sub-clause:

Where it is necessary for a pipeline to pass under existing services, the Contractor shall carefully excavate and backfill around them. During the course of the work, the services shall be adequately supported to the satisfaction of the Employer's Agent. Any damage shall be reported without delay and shall be made good by the Contractor before backfilling.

PSDB 5.4 Excavation

Add the following to this sub-clause:

Where the pipe trench crosses surfaced roads the Contractor shall neatly cut four parallel grooves into and through the "black top" before excavating between the inside 2 grooves. The outside 2 grooves should be 100 from the inside ones. The cost of this operation, where not scheduled separately, will be deemed to have been included in the general rates for excavation.

PSDB 5.5 Trench Bottom

Add the following to this sub-clause:

Unsuitable material shall only be excavated once the Employer's Agent has given a written instruction to this effect. Backfilling material for over excavation shall comply with the requirements of SANS 1200 LB and shall be compacted to 93 % modified AASHTO.

PSDB 5.6 Backfilling

PSDB 5.6.1 General

Add the following to this sub-clause:

Notwithstanding the requirements of sub-clauses PSDB 5.6.1 and 5.6.6, no pipe joint or pipefitting shall be covered by either the blanket or the backfill prior to the successful completion of the visual inspection and the pressure testing of the relevant section of the pipeline and without the written permission of the Employer's Agent.

PSDB 5.6.2 Material for backfilling

Add the following to this sub-clause:

No backfilling may be done unless it is authorised by the Employer's Agent. Trenches must be backfilled and compacted to 90% modified AASHTO to at least 300mm above the pipe soffit in layers of 150mm around and above the pipe and care should be exercised to prevent damage to the pipe. Subsequent layers may be compacted in 175mm layers. Except where backfill material is in the opinion of the Employer's Agent moist enough; water must be added to facilitate compaction.

In the event of no suitable material being available around the pipe for backfilling the trench in question, the Contractor must obtain suitable material from other excavations, transport it to the site and remove the unsuitable material to an approved dumping site. If no suitable material is thus obtainable,

the Contractor must sift the material obtained from the trench through a sieve with a 10mm mesh, but, if above mentioned procedure is not practical, the Employer's Agent may instruct the Contractor to import suitable material from approved sources and the Contractor will be under obligation to remove the unsuitable material to a dumping site.

If any settlement occurs during the Construction Period or before the end of the defect's liability period, the Contractor must rectify such settlement to the satisfaction of the Employer's Agent.

After all the excavations and backfilling have been completed, the surplus material and all additional material must be removed from the site to the satisfaction of the Employer's Agent.

PSDB 5.6.3 Disposal of Soft Excavation Material

Add the following to this sub-clause:

Surplus material or unsuitable material which is not disposed of within the trench servitude shall, on the instruction of the Employer's Agent, be disposed of at approved tipping sites to be located by the Contractor.

The prior approval of the Employer's Agent must be obtained before surplus material may be deposited, spread and levelled at agreed sites within the area of the works.

PSDB 5.6.4 Disposal of intermediate and hard rock material

Add the following to this sub-clause:

Surplus intermediate and hard rock material from trench excavations shall, on the instruction of the Employer's Agent, be disposed of at approved tipping sites to be located by the Contractor.

The prior approval of the Employer's Agent must be obtained before surplus material may be deposited, spread and levelled at agreed sites within the area of the works.

PSDB 5.7 Compaction

PSDB 5.7.2 Areas subject to traffic loads

Add the following to this sub-clause:

In areas subject to traffic loading and in constructed footways, compaction shall be done as directed by the Employer's Agent.

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.3 Scheduled Items

PSDB 8.3.5 Existing Services That Intersect or Adjoin A Pipe Trench

Add the following to the end of the sub-clause:

v. Notifying and attending upon the proprietor of the service,

vi. Supporting and protecting the service while the pipeline is installed, inspected, tested and backfilled.

SANS 1200 DM : EARTHWORKS (ROADS, SUBGRADE)

PSDM 5.2.2.4 Temporary Stockpiling of Materials

The Contractor shall programme the Works in such a way that double handling of material is minimised. No additional payment will be made for temporary stockpiling or extra handling where materials must be stockpiled temporarily.

PSDM 5.2.4.3 Topsoiling

The final thickness of topsoil shall be at least 100 mm.

PSDM 7.2 Process Control

The Contractor shall provide and maintain laboratory equipment on site to perform the following tests or make arrangements to the satisfaction of the Employer's Agent to have them done as and when required:

a. Indicator Tests.

b. Sieve Analysis.

c. Field Compaction Tests.

d. California Bearing Ratio's (C.B.R.'s)

e. Mod. AASHTO Density Tests

SANS 1200 G: CONCRETE (STRUCTURAL)

PSG 3 MATERIALS

PSG 2.3 Definitions

PSG 2.3 b) Quality

Change the following Sub-Clause:

Sample (of concrete). The minimum volume of uncompacted freshly mixed concrete required in terms of SANS Method 861-2 for a designated test (eg 16 dm^3 for the compressive strength test for 3 cubes of nominal side 150 mm).

PSG 2.3 c) Strength

Change the following Sub-Clause:

Valid test result. The average result obtained from the testing of three test cubes of concrete in accordance with SANS Method 862-1, Method 861-3 and Method 863.

PSG 3.2 Cement

PSG 3.2.1 Applicable Specifications

Add the following:

Change this Sub-Clause as follows:

Cementitious materials for concrete shall comply with:

a. SANS 50197-1-Cement-part 1: Composition, specification and conformity criteria for common cements.

b. SANS 55167-1: 2011 Part 1-Ground granulated blast-furnace slag.

c. SANS 55450-1: 2011 Part 2-Fly ash.

d. SANS 53263-1: 2011 Silica fume for concrete Part 1.

Under no circumstances shall a “masonry cement” complying with SANS 50413-1 be used for concrete.

Before any concrete is produced, the Contractor shall submit full details of the cement to be used for the production of concrete to the Employer’s Agent for approval. The name of the manufacturer of the cement and the place of manufacture shall also be submitted for approval.

PSG 3.2.2 Alternative Types of Cement

Add the following to this Sub-Clause:

The following materials may be used:

CEM II as described in SANS 50197-1.

A site blend comprising, by mass:

70 parts of CEM I.

30 parts of fly ash.

The type of cementitious material to be used for specific structures or structural elements may be specified by the Employer’s Agent.

For concrete pavements and floors that have joints sawn at an early age, the strength class of the cementitious material shall be 42,5N, 42,5R 52,5N or 52,5R.

PSG 3.2.3 Storage of Cement

Add the following to this Sub-Clause:

Where the cement is supplied in bags, the bags shall be closely and neatly stacked to a height not exceeding 12 bags, and they shall be so arranged that they can be used in the order in which they were delivered to the Site.

Cement shall not be kept in storage for longer than 6 weeks from the date of manufacture without the Employer's Agent's permission.

The Employer's Agent may order the removal of cement, which is older than 6 weeks, from the Site or the alteration of the design mix if he does allow its use. Alternatively, he may allow the cement to be used in concrete of less critical importance, as in blinding layers.

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 3.5 Admixtures

PSG 3.5.1 Approval of Admixtures Required

Add the following:

a. Water proofing additive with tracing agent or similar approved.

b. Minimum dosage 0,8% by weight of cementitious content, with 20year warranty and all to manufacturers specifications. Concrete to be placed, protected and cured according to SANS 10100-2"

PSG 3.5.3 Specifications:

Add the following Sub-Clause:

Admixtures shall comply with the requirements of ASTM C-494 and full details of the brand and type shall be submitted to the Employer's Agent for approval. Air entraining agents shall comply with the requirements of ASTM C-260 and

full details of the brand and type shall be submitted to the Employer's Agent for approval.

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. One concrete mixer of sufficient capacity to complete a section of the floor or road between construction joints within 4 hours and without interruption.

b. Two concrete vibrators, at least one of which shall be powered by an internal combustion engine.

c. One air compressor.

d. Suitable and adequate plant to transport concrete and other material and equipment at all stages of construction.

e. 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 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."

PSG 4.2 Batching Plant

Add the following Sub-Clause:

d. admixtures may be batched to an accuracy of within 2 % of the mass required.

PSG 4.5 Formwork

PSG 4.5.1 Design

Add the following:

"All formwork or scaffolding required for any part of the Works shall be designed by the Contractor, and before commencing with the erection of any formwork or scaffolding, the Contractor shall submit the methods he proposes to use to the Employer's Agent for approval. The Employer's Agent has the authority to order alterations to the design or the sizes of any part of the formwork or scaffolding. The Contractor shall check the safety and suitability of all such alterations. The fact that the Employer's Agent has approved or altered any part of the formwork of scaffolding shall not be construed as relieving the Contractor of his responsibility with regard to the strength and stability of the formwork or scaffolding."

PSG 4.5.2 Finish

Add the following to this Sub-Clause:

All external corners shall be chamfered by the fixing of fillet strips into the corners of the formwork to form 20 mm x 20 mm chamfers, all at no extra payment.

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.

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."

Only patented ties shall be used on water-retaining structures. Ties must be suitable for grouting to a depth at least equal to the concrete cover or 50 mm. Details of ties to be used shall be submitted to the Employer's Agent for approval.

PSG 5 CONSTRUCTION

PSG 5.1 Reinforcement

PSG 5.1.2 Fixing

Add the following:

"The Employer's Agent will inspect the reinforcing after it has been fixed in place, the formwork has been cleaned, cover blocks have been positioned, and 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, whichever is the largest."

The cover of concrete over reinforcement shall be measured from the outside of any reinforcement bar or stirrup. Minimum cover shall be in accordance with the dimension shown on the relevant drawing. Unless otherwise shown on the drawings, minimum cover to reinforcement shall be 50mm.

PSG 5.2 Formwork

PSG 5.2.1 Classification of Finishes

a. Smooth

Add the following to this Sub-Clause:

Smooth formwork is required where concrete will be in contact with backfill or where exposed formed surfaces will not readily be visible.

c. Special

Add the following to this Sub-Clause:

Special smooth formwork is required where concrete surfaces are exposed and is to be carried down to 150mm below adjoining ground or paving level.

Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolorations shall be made good and repaired by approved methods including rubbing down or grinding to the complete satisfaction of the Employer's Agent. The finish of the concrete shall be accurate to Degree of Accuracy I as defined in terms of Clause 6.

Patching of the tie holes to match the colour of the concrete where exposed.

PSG 5.2.2 Preparation for Formwork

Add the following:

Surfaces of formwork that are to be in contact with concrete shall be treated with an approved release agent to prevent adhesion of the concrete during stripping. The joints between continuous formwork elements shall be closely butted and, where necessary, if undue leakage is expected, the joints shall be caulked, taped or packed with a sealing gasket, all at no extra payment. Paper, cloth or similar materials shall not be used for this purpose.

Any discolouration to the concrete by the release agent shall be permanently removed.

Construction joints shall be positioned as shown on the Drawings.

PSG 5.2.5 Removal of Formwork

Add the following subclause:

PSG 5.2.5.7 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.

PSG 5.5 Concrete

PSG 5.5.1 Quality

PSG 5.5.1.2 Consistency

Add the following to this Sub-Clause:

The slump, measured in accordance with SANS Method 862-1, shall be not less than 50 mm and not more than 80 mm, unless permitted otherwise by the Employer's Agent for specific applications.

PSG 5.5.1.5 Durability

Add the following to this Sub-Clause:

All water retaining structures shall be deemed to be exposed to severe conditions. The cement/water ratio shall be determined by the strength of the concrete specified but shall not be less than 2.0.

In addition to these requirements the cementitious material content shall not be less than 325 kg/m^3 for structural concrete Grade 35/20.

For reinforced concrete the cement content should not exceed either 400 kg/ m^3 of ordinary Portland cement or cements containing G.G.B.S. or 450 kg/m^3 where cements containing P.F.A. are used. For prestressed concrete the maximum cement content may be increased to 500 kg/m^3 or 550 kg/m^3 respectively.

PSG 5.5.1.7 Strength Concrete

Add the following to this Sub-Clause:

Before the commencement of any construction work, the Contractor shall submit a concrete mix design report to the Employer's Agent for approval. A reputable commercial laboratory shall compile this concrete mix design report.

Unless specified differently the grade of concrete to be used shall be as follows:

a. Grade 35/20: All reinforced concrete structures

b. Grade 35/20: All paving slabs and floor slabs

c. Grade 15/20: Unreinforced foundations, pipe encasements and blinding

d. Grade 10/20: Mass concrete and concrete filling

e. Grade 15/10: Screeds and benching

PSG 5.5.2 Batching

Add the following to this Sub-Clause:

Equipment for mass batching shall be clearly marked to show the mass of each material required for a batch.

PSG 5.5.2.3 Aggregates

Add the following to this Sub-Clause:

Batching of aggregates shall be by mass to an accuracy of within 2 % of the mass required. No volume batching will be permitted.

PSG 5.5.3 Mixing

PSG 5.5.3.2 Ready-Mixed Concrete

Add the following:

Ready-mixed concrete may be used on the Site. The Contractor shall take samples for testing from every load delivered to the Site.

PSG 5.5.5 Placing

Add the following:

Concreting of the floor between construction joints shall be carried out in both directions from a point on the floor in order to close the gap with fresh concrete.

PSG 5.5.6 Compaction

Add the following to this Sub-Clause:

PSG 5.5.6.3 Compaction shall be carried out by mechanical vibration with suitably sized equipment. Compaction by hand shall not be permitted.

PSG 5.5.6.5 Particular care shall be taken with the top section of the walls of the reservoir to prevent cracking.

PSG 5.5.7 Construction Joints

Add the following:

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 scabbling of the concrete where steel reinforcement is continuous.

PSG 5.5.7.1b) Install a controlled expansion self-healing concrete waterstop (Size: 19 x 25 x 5mm), guaranteed as a system with the crystalline waterproofing additive with tracing agent, to primed joint surface between concrete pours by an approved applicator as per manufacturer's instructions.

PSG 5.5.7.3 a) Construction joints when concrete is not more than 24 hours old:

The surface of the concrete shall be brushed with a wire brush, loose material removed and the surface dampened . New concrete shall be placed directly in contact with the old concrete and compacted thoroughly.

b) Construction joints when concrete is more than 24 hours old:

The surface of the concrete shall be sand blasted or chipped with a light hammer, and swept clean. The surface shall then be wetted and allowed to become surface-dry before new concrete is placed directly in contact with the old concrete and compacted thoroughly.

Add the following Sub-Clause:

PSG 5.5.7.3 e) No vertical construction joints will be permitted in circular tanks.

PSG 5.5.8 Curing and Protection

Add the following:

The curing methods of retaining the formwork in place or covering with a waterproof membrane are strongly recommended. Concrete will not be paid for unless properly cured and proof of curing is continuously visible on site.

The minimum period of moist curing shall be:

- 5 days for normal weather (temperature 18°C to 22°C, 65 % RH, low wind speeds).
- 7 days for hot weather with drying winds.
- 9 days for cold weather (temperature 5°C to 12°C).

PSG 5.5.11 Watertight Concrete

Add the following:

All structures shall be deemed to be water retaining unless otherwise specified.

PSG 5.5.11.1 Testing of Water Tank

For a test of liquid retention, the structure should be cleaned and initially filled to the normal maximum level with the specified liquid (usually water) at a uniform rate of not greater than 2 m in 24 h.

When first filled, the liquid level should be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for a maximum design crack width of 0.1 mm or 21 days for 0.2 mm or greater. After the stabilizing period the level of the liquid surface should be recorded at 24 h 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, should not exceed 1/500th of the average water depth of the full tank, 10 mm or another specified amount.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls should be assessed against the requirements of the specification. Any necessary

remedial treatment of the concrete, cracks, or joints should, where practicable, be carried out from the liquid face. When a remedial lining is applied to inhibit leakage at a crack it should have adequate flexibility and have no reaction with the stored liquid.

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

PSG 5.5.11.2 Testing of Roofs

The roofs of liquid-retaining structures should be watertight and should, where practicable, be tested on completion by flooding the roof with water to a minimum depth of 25 mm for 24 h or longer if so specified. Where it is impracticable, because of roof falls or otherwise, to contain a 25 mm depth of water, the roof should have water applied by a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 h. In either case the roof should be considered satisfactory if no leaks or damp patches show on the soffit. Should the structure not satisfy either of these tests, then after the completion of the remedial work it should be retested in accordance with this clause. The roof insulation and covering should be completed as soon as possible after satisfactory testing.

PSG 5.5.13 Grouting

Add the following:

PSG 5.5.13.1 Materials

a. Water - Water for grout shall comply with the requirements given in Sub-Clause 3.3 of SANS 1200 G: 1982 (2002-07-30)
b. (Aggregates - Notwithstanding the requirements of Sub Clause 3.4.1 of SANS 1200 G, the grading of fine aggregate (sand) and coarse aggregate (stone or pea gravel) shall conform to the grading given in Tables 1 and 2, respectively, below.

c. Cementitious material – This shall be type CEM II complying with SANS 50197-1 and of strength class 42,5 N or higher.
d. Admixtures - Admixtures shall comply with the requirements of Sub-Clause 3.5 of SANS 1200 G: 1982 (2002-07-30) and shall have a proven record of satisfactory performance under conditions encountered in the Republic of South Africa.
e. Proprietary grouting materials - Unless otherwise approved by the Employer's Agent, proprietary grouting materials shall be obtained ready mixed in sealed pockets as supplied by the manufacturers.

TABLE 1 - SAND		**TABLE 2 - STONE OR PEA GRAVEL**	
1	2	1	2
Test sieve nominal aperture size (mm)	% Passing (by mass)	Test sieve nominal aperture size, (mm)	% Passing (by mass)
9,75 4,75 1,18 0,3 (300 µm) 0,15(150 µm)	100 95 - 100 45 - 65 5 - 15 0 - 5	9,5 4,74 2,36	100 95 - 100 0 - 5

PSG 5.5.13.2 Preparation and Procedures

a. Before a machine or structural bedplate is placed on the concrete the following steps shall be carried out:

1. All defective concrete, laitance, dirt, oil, grease, and loose material shall be removed from the concrete foundation by bush hammering, chipping, or other means until sound clean concrete is obtained. The surface of the foundation shall be scabbled but shall not be so rough as to interfere with proper placing of the grout. All foundation bolt sleeves

shall be cut out or cut off flush if the sleeves cannot be removed. The top of the foundation shall be re shaped if necessary.

2. The underside of each steel base, particularly in the bearing areas, shall be cleaned and any burrs and ragged edges removed before the base is placed in its final location.

3. All holding down bolt sleeves shall be thoroughly cleaned of any materials that may prevent the grout from flowing freely to the bottom of the bolt sockets.

b. The base shall be properly aligned and levelled and shall be maintained in that position during grouting.

c. After the machine or structural bedplate has been placed the following precautions shall be observed:

1. Shimming shall be kept to a minimum. Steel plates shall be used for packing and shall be ground to the required thickness, where necessary.

2. Before grouting is started all loose dirt, oil, grease, and other foreign matter on the surface of the foundation, the undersides of bedplates, and in the bolt holes shall be removed by means of compressed air or other approved means. The surface of the foundation slab shall be thoroughly saturated with clean water, and all free water shall be removed from the surface and the bolt holes just before the grout is placed.

3. Grouting shall not be carried out until the alignment of all units to be grouted has been checked and approved by the Employer's Agent.

4. Special care shall be taken with grouting in hot or cold weather to ensure proper setting and gain of strength and, in the case of proprietary grouting materials, by having ice or hot water available, as the case may be, in accordance with the instructions of the

manufacturer. Enclosures shall be provided for the grout such that, until it has set, its temperature will be in the range 15°C - 27°C.

Shields to protect the grout from the sun and from hot winds shall be provided by the Contractor when so ordered.

PSG 5.5.13.3 Formwork

Formwork for grouting shall comply with the applicable requirements of Clause 5.2 of SANS 1200 G: 1982 (2002-07-30). Forms shall be caulked where necessary. Adequate clearance between forms and bedplates shall be provided to enable the grout to be worked into place.

PSG 5.5.13.4 Mixing (All Free-Flowing Grouts Except Epoxy Grouts)

The grout shall be mixed to a homogeneous uniform mixture and delivered ready for placing at a temperature between 15 °C and 25 °C.

The materials and water shall be mixed in a mortar mixer for at least 3 min. or, in the case of small jobs only, shall be thoroughly mixed by hand, the entire mass being turned over enough times to ensure even distribution of its components.

The mixing shall be done as close as possible to the place(s) where the grout is placed. No more grout shall be mixed at any one time than can be placed in a period of 20 min. After the grout has been mixed, it shall not be retempered by the addition of water.

PSG 5.5.13.5 Grouting (All Free-Flowing Grouts Except Epoxy Grouts)

The grout shall be placed quickly and continuously to avoid the undesirable effects of over working. These effects are segregation, bleeding, and breaking down of initial set. The method of placement shall be subject to approval. The means of placing the grout shall be such that the grout will completely fill the space to be grouted, thoroughly compacted, free of air pockets, and will have

evenly distributed contact over an area in excess of 80% or, in the case of expanding grout, 95% of the bearing area of the item to be supported.

Wherever practicable, grout shall be placed from one side only and where this is not practicable, care shall be taken to ensure that any entrapped air is released.

After the grout has taken its initial set:

a. the forms shall be removed.

b. excess grout shall be so cut away as to leave a smooth and neatly finished job.

c. except where the grout is intended to provide resistance to side thrust, all edges shall be trimmed at 45° to the vertical, from the bottom edge of the bedplate and

d. all excess grout on or about the bedplates shall be removed.

Damage to paintwork, if any, shall be repaired within 24 hours. Packing plates, shims, and other levelling devices shall remain in position.

PSG 5.5.13.6 Dry-Packed Grout (Standard Dry Sand and Cement Grout)

Dry-packed grout shall have a minimum compressive strength at 28 d of 20 MPa. The quantity of water added after placing shall be kept to a minimum consistent with placing conditions, and the cement, sand and, where applicable, pea gravel proportions by mass shall be as follows:

a. Where the clearance between bedplate and foundation is 25 mm or less : 1 part of cement and 2 parts of sand;

b. Where the clearance exceeds 25 mm: 1 part of cement, 1 part of sand, and 1 part of pea gravel.

Dry packed grout shall be rammed by means of tamping rods against formwork placed along three sides of the bedplate.

PSG 5.5.13.7 Non-Shrink Grout with Metallic Aggregate

The manufacturer's instructions shall be observed when non shrink grout with metallic aggregate is used.

Where the clearance between the bedplate and the foundation is less than 50 mm a sand-based mix shall be used. Where the clearance exceeds 50 mm the Employer's Agent may order a mix with a base of sand plus pea gravel to be used.

PSG 5.5.13.8 Expanding Grout with Powdered Aluminium Additive

The manufacturer's instructions shall be observed when an expanding grout with powdered aluminium additive is used. Where the clearance between the bedplate and the foundation is less than 25 mm, a sand-based mix shall be used.

Where the clearance exceeds 25 mm the Employer's Agent may order mix with a base of sand plus pea gravel to be used.

Each batch shall be mixed for at least 6 min. after the powdered aluminium has been added. Where a ready mixed grout is used, the powdered aluminium shall be added at the placing site and the batch mixed as specified in PSG 9.4. Grout shall be placed within 45 min. after the addition of the powdered aluminium.

The Contractor shall not use powdered aluminium additive when the ambient temperature is below 5°C.

PSG 5.5.13.9 Epoxy Grout (Epoxy Mortar Type Only)

The manufacturer's instructions shall be observed when an epoxy grout is used.

PSG 5.5.13.10 Testing (Clause 7)

The Contractor shall, where so ordered, carry out a site test for each grouting procedure and each grouting gang to be used. The tests shall be carried out on a dummy bedplate similar in configuration to that, which is to be grouted, but not exceeding 1 m in area unless otherwise ordered.

When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80 % with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95 %. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Employer's Agent.

The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of Sub-Clause 7.2.1 to 7.2.3(f) SANS 1200 G: 1982 (2002-07-30).

Add the following Sub-Clauses:

PSG 5.5.16 No Fines Concrete

PSG 5.5.16.1 Materials

Cement, aggregate and water shall comply with the requirements of Clause 3 of this section.

Each size of aggregate shall be a single sized aggregate graded in accordance with SANS 1083:2006.

PSG 5.5.16.2 Classes of No-Fines Concrete

No fines concrete shall be classified by the prefix NF and the size of the aggregate to be used. Class NF 20 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 no fines concrete shall be as follows:

Class	Aggregate per 50 kg cement
NF 40	0,33 m^3
NF 20	0,30 m^3
NF 10	0,27 m^3

PSG 5.5.16.3 Batching and Mixing

Cement shall be measured by mass or full bags of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows.

The quantity of water added shall be just sufficient to form a smooth grout that will adhere to and completely coat each and every particle of aggregate and to be just wet enough to ensure that, at points of contact of the aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20l of water per 50 kg of cement.

Mixing shall be carried out in an approved batch type mechanical mixer, but small quantities may be hand mixed.

PSG 5.5.16.4 Placing

No fines concrete shall be placed in accordance with the procedure agreed on by the Employer's Agent. It shall be placed in its final position within 30 minutes of mixing.

The no fines concrete shall be worked sufficiently to ensure that it completely fills 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 may the no fines concrete be vibrated.

PSG 5.5.16.5 Protection

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished in one or more of the following ways:

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.

PSG 5.5.17 Joints in Structures

PSG 5.5.17.1 Materials

a. General

All materials used in the forming, construction and sealing of permanent joints, as well as all proprietary or custom-built expansion joint assemblies shall be subject to the approval of the Employer's Agent.

When required by the Employer's Agent, the Contractor shall submit test certificates from an approved independent testing authority to show that the respective materials comply with the specified requirements, or a certificate from the patent holder or designer to certify that the manufactured item complies in all respects with relevant product specifications.

b. Joint filler

Joint filler shall comply with the requirements of the following specifications:

i. American Association of State Highway Officials (A.A.S.H.O.) Standard Specification M153 54 Type I and III;

ii. National Transport Commission "Standard Specification for Roads and Bridge Works";

iii. Department of Public Works PW471 "Specification of Materials and Methods to be used" Section 3.13 Expansion Joints;

Joint fillers shall consist of closed cell expanded polyethylene with a density of not less than 100 kg/m³.

c. Sealants

Joint sealers shall consist of a two-component polyurethane sealing compound complying with the requirements of SANS 1077: 2009 (Ed. 1.2s).

The Contractor may use other sealants if approved by the Employer's Agent after submission of full specifications and information at tender stage.

d. Waterstops

Waterstops shall be of natural rubber, or plasticized, virgin, non biodegradable PVC, and of the type specified or shown on the Drawings.

i. Natural rubber waterstops shall comply with the requirements of CKS 388.

ii. Flexible polyvinyl chloride (PVC) rubber waterstops shall comply with the requirements of CKS 389.

e. Accessory materials

i. Primers

When a primer is to be used in conjunction with the sealant, it shall be of the prescribed proprietary material.

ii. Adhesives

Adhesives used in conjunction with preformed seals shall be of a proven and approved type, which is compatible with the material of the seal.

iii. Bond breakers

Polyethylene tape, coated papers, metal foils or similar material may be used where bond breakers are required.

iv. Back-up material

Back-up material shall consist of a compressible material of correct width and shape in order to ensure that it will be in approximately 50 % compression after installation and that the sealant can be formed to the specified depth.

Back-up materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

f. Storage

All materials used in the forming, construction and sealing of permanent joints and all proprietary or custom built expansion joint assemblies shall be stored off the ground under cover that provides adequate protection against sunlight, physical or chemical damage or other factors that may cause deterioration.

PSG 5.5.17.2 Filled Joints

Filled joints shall be accurately formed to the dimensions shown and with the filler material specified on the Drawings. The filler shall be secured in position so that it will not be displaced during or after concreting if the filler is to remain permanently in the joint. In addition the filler shall be provided with a cut line prior to installation, e.g. factory perforated on the correct depth. This cut line, intended to aid removal of a portion of the filler to make room for the sealant, shall be in a position which coincides with the depth of the sealant.

Wherever polystyrene or a similar material, which is susceptible to damage, is used to form joints, it shall be lined with a hard surface on the side to be

concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

PSG 5.5.17.3 Sealing of Joints

a. General

Sealed joints shall be made watertight over the full length of the joints, unless otherwise permitted by the Employer's Agent, and the joint dimensions shall be as shown on the Drawings.

b. Preparation of Joints

The reaming of joints by sawing or other means shall be undertaken when edge spalling or ravelling can be avoided and shall be subject to the Employer's Agent's approval.

After removal of the temporary filler material up to the cut line or the breaking out of the excess concrete, the inside faces of the joint shall be wire brushed or grit blasted to remove all laitance and contaminants. Thereafter the joint shall be cleaned and blown out with compressed air to remove all traces of dust. Solvents shall not be used for removing contaminants from concrete and porous surfaces.

Care shall be taken to ensure that primers or adhesives are applied only to surfaces that are absolutely dry. The primer or adhesive shall be applied strictly in accordance with the manufacturer's instructions. Unless otherwise specified, the primer shall be applied within the temperature range of 10°C to 40°C and the sealant shall be applied after the curing period of the primer and within the period during which the primer remains active.

A bond breaking tape (or rope) shall be applied to the filler prior to adding the sealant in order to prevent bondage between sealant and filler.

c. Sealants

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. The trapping of air and the formation of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance flush with the edges of the concrete or to the specified depth.

Thermoplastic hot poured sealants shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C.

Two part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot life period, which shall commence once the base and activator of the sealant have been combined.

d. Preformed compression seals

The seal shall be inserted and secured with a lubricant adhesive which covers both sides of the seal over the full area in contact with the inside faces of the joint. The lubricant adhesive shall be applied immediately before the seal is inserted.

The seal shall be installed in a compressed state, with the appropriate equipment, so that the seal will remain in compression even under the most adverse conditions. The final position of the seal shall be as shown on the Drawings or as directed by the Employer's Agent.

Joints in seals shall be bonded or fused and shall be only at positions agreed on by the Employer's Agent.

e. Waterstops

i. General requirements

The waterstops shall be supplied in unjointed standard production lengths. Site jointing shall be limited to the absolute minimum. Where lengths in excess of

the standard production lengths are required, such longer lengths shall preferably be factory jointed.

At intersections, transitions and abrupt changes of direction, factory moulded watertight junction pieces shall be used so that any site jointing can be restricted to simple joints.

When a waterstop with a centre bulb is intersected, the centre bulb shall be continuous throughout the intersection irrespective of the makeup of the intersection.

ii. Rubber Waterstops

All joints shall be vulcanized and shall have a tensile strength of at least eighty (80) per cent of that of the unjointed material for water retaining structures, and fifty (50) per cent for other structures.

Site joints shall be vulcanized joints made in accordance with the requirements of these Specifications and the manufacturer's instructions, and with equipment prescribed or supplied by the manufacturer and approved by the Employer's Agent.

The vulcanizing process shall be a hot process with strict control on the pressure, the temperature and the time. The vulcanizing temperature shall be between 150 ºC and 160 ºC. The rubber shall not be heated above 160ºC. The vulcanizing time for the specific type of rubber of the waterstops involved shall be determined with a curometer for the abovementioned vulcanizing temperatures before a vulcanized joint is made. The recommended pressure between the two sections which must be vulcanized is 3,4 MPa and the minimum allowable pressure is 2,4 MPa.

The contact faces of the sections to be jointed shall be accurately and evenly cut at the angle shown on the Drawings or prescribed by the Employer's Agent to obtain a precise fit and complete contact.

Care shall be taken to keep centre bulbs unobstructed at the joints so that the lateral flexibility of the waterstops will not be affected by the presence of clotted rubber inside the bulbs.

The rubber of the waterstop shall not have any porosity of voids between the contact faces of the sections and/or at the finished vulcanized joint, especially at the centre bulb.

The vulcanizing equipment shall comply with the following minimum requirements:

The heating elements shall be equipped with an automatic temperature control device to keep the elements at the required temperature.

It shall be equipped with an automatic temperature control device to keep the heating elements at the required temperature, with a device to measure the temperature at the vulcanizing plane, a device to measure the temperature applied to the external faces of the rubber, and with a pressure gauge to regulate the applied pressure within the specified limits in relation to the liquidity of the rubber.

During the vulcanizing process, the pressure shall be spread evenly over the entire contact area and the pressure plates shall be sufficiently rigid that they will not bend under the applied pressure. The cut-out forms of the pressure plates shall fit accurately over the waterstops so that all the faces of the waterstops will be in contact with the pressure plates.

The planes of contact of the two sections of the waterstops to be joined together shall be prevented from sliding from each other when pressure is applied to the plates.

A shield shall be available to shield the apparatus against wind, rain, etc. when joints are made in the open to ensure proper temperature control.

The apparatus as a whole shall be safe in all respects and shall comply with all the appropriate statutory requirements.

iii. Plasticized, Flexible PVC Waterstops

The waterstops shall be manufactured from high quality virgin material and shall not contain any scrap or reclaimed material. The waterstops shall be light coloured to reduce heat absorption when exposed to sunlight.

The waterstops shall be precision moulded or extruded to the required cross sectional profile, they shall be free from porosity or other imperfections, and shall be provided with eyelets so that they can be securely fixed to prevent displacement during concreting.

All joints shall be butt jointed hot welded joints. Where joints cannot be factory made, Site joints shall be made in accordance with the manufacturer's instructions with equipment prescribed or supplied by the manufacturer and approved by the Employer's Agent.

PSG 5.5.18 Building in of Pipes

The Contractor under this Contract shall be responsible for building in or caulking and making watertight around all pipes and fittings which pass through walls or under floors of the structures, irrespective of whether the Contractor himself supplies and installs the pipes and fittings, or the Employer purchases the pipes and fittings and the Contractor under this Contract takes delivery and installs them, or some other contractor (e.g. a plant supplier) supplies and installs the pipes and fittings in recesses or through holes left in the various structures for the reception of such pipes and fittings. In the latter case, the Contractor under this Contract will be paid for forming the openings for and caulking of these pipes or fittings under the item provided for this purpose in the Schedule of Quantities.

Where pipes or specials are required to pass through or be set into concrete work, holes shall be left in the concrete.

Before commencing, the positioning in holes of any pipes/specials the Contractor shall:

a. cut the reinforcement to allow the pipe to be installed.

b. remove all shuttering and boxing remaining in the holes.

c. make any alterations required to the position and shape of the holes.

d. thoroughly clean the sides of the holes so as to obtain a satisfactory bond surface for the new concrete; and

After accurately positioning the pipes/specials in their respective holes, the Contractor shall fix the pipes/specials in the holes.

Immediately before grouting is carried out by the placing of mortar and concrete around the pipes, the surface of the existing concrete shall be saturated with water. All surplus water shall be removed, and the surface covered with a layer, approximately 12 mm thick, of mortar consisting of 3 parts of concrete sand and 1 part of cement.

The concrete ingredients shall be mixed and placed as dry as possible to obtain a dense, waterproof concrete. Where a watertight seal is required, the concrete shall be carefully worked around the puddle flange, if any, and the pipe barrel or body of the special, and shall be vibrated in layers so as to obviate any falling away from pipe/special surfaces of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass. A spare vibrator with an independent power source shall be kept in readiness to ensure continuity of placing in the event of the breakdown of the duty vibrator.

Smooth formwork that has been suitably strengthened for use with a vibrator shall be provided for facing the concrete around each pipe/special.

Alternatively, pipes may be cast into the wall in which case the pipes shall be installed in the required position with the formwork fixed around them and the concrete worked thoroughly into contact.

PSG 5.5.19 Foundations for Mechanical Equipment

The mechanical contractors shall supply the holding down bolts for all mechanical equipment, together with all dimensions and other details necessary for the construction of the pedestals and holding down bolt pockets, or the fixing of the bolts. The Contractor shall either form pockets for the holding down bolts to be installed at a later stage or he shall position the bolts before the concrete is cast as ordered by the Employer's Agent. The mechanical contractor shall fix, align and level the mechanical equipment after which the Contractor shall grout up the units solidly by filling the voids inside and under the baseplates as ordered with an approved non shrink grout.

PSG 5.5.20 Testing for Watertightness

The structure that has to be tested for water tightness shall be filled by water being gradually let in 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 structure shall be allowed to remain filled for a period of two weeks to permit complete absorption of water by the concrete.

Any loss of water, which may have occurred, shall then be made up by again filling the structure to the top water level and by allowing the water to remain undisturbed for a period of not less than four days. The structure shall be considered to be watertight if the drop in level in 96 hours (less the drop caused by evaporation) does not represent more than 0,06 % of the volume of the structure.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water, being recorded.

The Contractor is free to attend the taking of all measurements by the Employer's Agent.

In the event of an appreciable leakage being evident or visible at any stage of the filling or testing, or in the event of the final degree of watertightness being unsatisfactory, the Contractor shall, when so ordered by the Employer's Agent, discontinue such filling or testing that shall, at his own expense, take approved

steps to rectify the leakage, until a test proves that a sufficient degree of watertightness has been obtained.

Before the expiry of the period of maintenance, the Employer's Agent shall have the right to retest the structure for watertightness; results of such further tests will be made available for the information of the Contractor. In the event of these tests indicating an unsatisfactory degree of watertightness, the Employer's Agent will, before issuing the final certificate, again require the Contractor to rectify the leakage, at his own expense, in such a manner as will cause the least interruption of the water supply to consumers and as will ensure the soundness of the work, to the satisfaction of the Employer's Agent.

Should the failure of the structure to pass the first or any subsequent test for watertightness necessitate the draining of the structure, the Employer reserves the right to itself utilise the water by discharging it into its water reticulation network, in which case the Contractor:

i. shall not have to pay for the subsequent refilling of the structure.

ii. shall, if applicable, reimburse the Employer for any additional costs incurred to make the water fit for consumption; and

iii. shall not be entitled to claim for extra time whilst waiting for the water to be discharged into the network.

The costs of retesting the structure for watertightness shall be borne by the Contractor.

PSG 5.5.21 Sterilization of the Reservoir

After completion and before commissioning, the reservoir shall be cleaned, washed and disinfected.

All areas inside of the structure shall be washed to the satisfaction of the Employer's Agent and thereafter it shall be brushed with a 15mg/l calcium hypochlorite solution. Upon completion of the disinfection process, the wash

water shall be drained from the structure and disposed of at a suitable location offsite. Thereafter the water tightness test can be carried out.

PSG 6 TOLERANCES

PSG 6.2 Permissible Deviations

PSG 6.2.3 Specified Permissible Deviations

Add the following:

Degree-of-accuracy II is applicable.

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 subclause 6.2.3(d)(5) with the following:

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

PSG 7 TESTS

PSG 7.1 Facilities and Frequency of Sampling

PSG 7.1.1 Facilities

Add the following:

Testing will be done in accordance with SANS Methods 860, 861-3 and 863.

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

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

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, but samples for testing shall be taken of such concrete at the point of placing.

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.1 Measurement and Rates

PSG 8.1.1 Formwork

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 20 mm x 20 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 pump stations, valve 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 8.3 Reinforcement

Replace the contents of this subclause with the following:

"The unit of measurement for steel bars shall be the ton of reinforcement in place, in accordance with the Drawings or as authorised by the Employer's Agent.

The unit of measurement for welded steel fabric shall be the square meterage 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 8.2 Scheduled Formwork Items

Add the following pay item:

PSG 8.2.7 Chamfers larger than 20 mm x 20 mm

a. Size and member indicated **Unit: metre (m)**

b. Ditto for other sizes **Unit: metre (m)**

The unit of measurement shall be the metre length of chamfer formwork provided. Chamfers 20 mm x 20mm and smaller will not be measured for payment and their cost shall be deemed to be included in the rates tendered for formwork.

PSG 8.4.3 Concrete

Item to be priced as per SABS 1200G 8.4.3 but to include admixture specified in PSG 3.5.1.

PSG 8.4.7 Grouting

Rate to cover supply and installation of all grouting for ferrol holes in concrete tank walls made up of material specified in PSG 4.5.3.

PSG 8.5 JOINTS

Delete this pay item and add the following pay item:

PSG 8.5.1 Expansion Joints

Forming expansion joint (Width of joint to be stated) **unit: metre (m)**

The unit of measurement shall be the square metre net area of one face of the concrete that constitutes the joint.

The tendered rate shall cover the cost of all materials and labour for the construction of the joint as specified or shown on the drawings, including the cost of formwork, surface roughening and cleaning, testing and making good.

PSG 8.5.2 Filled Joints

Forming filled expansion joint (Thickness and width of joint to be stated, material of joint filler to be stated)

unit: metre (m)

The unit of measurement shall be the square metre net area of one face of the concrete that constitutes the joint.

The tendered rate shall cover the cost of all materials and labour for the construction of the joint, including formwork, supply and installation of joint filler as specified, testing and making good.

PSG 8.5.3 Sealed Joints

Sealing of joints (Size of finished seal to be stated. Material of joint sealer to be stated). **Unit: metre (m)**

The unit of measurement shall be the linear metre net length of the position where the sealant is applied.

The tendered rate shall cover cost of supplying, preparing and application of the joint sealer as specified including testing and making good. Other costs related to the joint will be covered by items PSG 8.5.1 or 2 as the case may be.

PSG 8.5.4 Joints with Waterstop

Separate items will be scheduled for:

a. Waterstops in a straight-line **Unit: metre (m)**

b. Waterstops on a curve **Unit: metre (m)**

c. Extra-over items (a) and (b) above for factory moulded intersection pieces (described)
Unit:Number (No)

Full description of waterstop with the relevant dimensions to be stated.

The unit of measurement shall be the linear metre net length of waterstop installed, measured along its central bulb.

The tendered rate shall cover the cost of supplying and installation of the waterstop. Other costs related to the joint will be covered by items PSG 8.5.1;

2 and/or 3 as the case may be. Regarding the intersection pieces, the rate shall also include the joining of the intersection piece on site with straight or curved water stops.

PSG 8.7 Grouting

Add the following pay items:

PSG 8.7(c) Grouting in of equipment supplied and installed by the Plant Supplier

i. using non shrink grout (state type) **unit: cubic metre (m^3)**

ii. using dry packed grout **unit: cubic metre (m^3)**

The unit of measurement shall be the cubic metre of completed grouting.

The tendered rate shall include full compensation for supplying of all materials, mixing, applying and finishing to a steel float surface finish after installation of the Plant.

Add the following pay items:

PSG 8.10 Testing Structures for Watertightness

The unit of measurement for testing for watertightness shall be the lump sum.

Unit:

Lump sum

The tendered rate shall include full compensation for the provision of all labour, plant and materials necessary for testing the structure for watertightness as specified, and for emptying it afterwards, all to the satisfaction of the Employer's Agent.

PSG 8.11 Sterilization of the Reservoir

The unit of measurement for sterilization shall be the lump sum.

Unit:

Lump sum

The tendered rate shall include full compensation for the provision of all labour, plant and materials necessary for sterilization as specified, and for emptying it afterwards, all to the satisfaction of the Employer's Agent.

PSG 8.12 Casting in Pipes

The tendered rate shall include full compensation for the provision of all labour, plant and materials necessary for the casting in of pipes (size, type and location indicated) as provided in Clause 5.5.18.

SANS 1200 H STRUCTURAL STEELWORK

PSH 2 INTERPRETATION

PSH 2.1 Supporting Specifications

a. SANS 1200 HA

PSH 3. STRUCTURAL STEELWORK

Replace the contents of this clause with the following:

All structural steelwork will be to SANS 1431: 2003, Grade S355JR.

PSH 3.6 Bolts, Nuts and Washers

PSH 3.6.1 Bolts and Nuts (Other than Friction Grip)

Add the following to this Sub-Clause:

All bolts and nuts shall comply with the requirements of SANS 136 and shall be 4.6 strength grade. Washers shall be provided at each nut and shall be of the same material (or coating where applicable) to match the bolt and nut. Single coil square section spring washers shall be fitted to all nuts subject to vibration.

Bolts other than jacking bolts shall project not less than 3 mm and not more than 10 mm from the heads of the nuts after tightening. An approved nickel based anti-seize compound shall be used on all stainless steel bolts and nuts.

Unless otherwise shown all bolts, nuts and washers shall be of the material as specified below:

Holding down bolts to be built into concrete work as well as bolts to be installed above ground level directly above and under water shall all be of stainless steel grade 304. Bolts for flexible couplings and flanges for underground installation shall be of the same material as the couplings or flanges. Bolts to be installed inside buildings shall be of the same material as the pipework and fittings. Corrosion protection shall be as specified in the Particular Specification G02: Corrosion Protection.

Suitable plastic sleeves and/or washers shall be used for protection against corrosion by bi-metallic action.

PSH 5 CONSTRUCTION

PSH 5.1.1 Shop Drawings

The Contractor is to provide the Employer's Agent with shop drawings at least 4 weeks before the Contract Commencement date.

The drawings shall be compiled in the official language of the Contract. Approved drawings shall form an integral part of the Contract documents. Drawings not accepted and signed by a professional Employer's Agent, shall not be used by the Contractor on the site of Works for construction purposes or the manufacturing of any member.

The Contractor shall submit completed drawings in accordance with this specification and shall not be entitled to claim for delays resulting from incomplete submittals that may lead to the rejection thereof. The Employer's Agent shall require a period of at least 21 working days for the reviewing of the submittals.

The following submission items are considered to be essential and shall form part of the shop drawing submittals:

- A complete material list clearly indicting the quantities of each member,
- Detail of each member showing the overall dimensions, drilling requirements and net weight, and
- Connection details for purlins fixing, bracing, sag rods and all members.

PSH 5.3.9 Protective Treatment

Delete this Sub-Clause and refer to the Particular Specification G02: Corrosion Protection.

SANS 1200HA: STRUCTURAL STEELWORK (SUNDRY ITEMS)

PSHA 2 INTERPRETATION

PSHA 2.1 Supporting Specifications

(c) SANS 1200 H

PSHA 3 MATERIALS

PSHA 3.3 Bolts, Nuts and Washers

PSHA 3.3.1 Bolts and nuts (other than friction grip)

Add the following to this Sub-Clause:

All bolts and nuts shall comply with the requirements of SANS 136 and shall be 4.6 strength grade. Washers shall be provided at each nut and shall be of the same material (or coating where applicable) to match the bolt and nut. Single coil square section spring washers shall be fitted to all nuts subject to vibration.

Bolts other than jacking bolts shall project not less than 3 mm and not more than

10 mm from the heads of the nuts after tightening.

Holding down bolts to be built into concrete work as well as bolts to be installed above ground level directly above and under water shall all be of stainless steel grade 304. Bolts for flexible couplings and flanges for underground installation shall be hot-dip galvanized in accordance with the requirements of SANS 763. Bolts to be installed inside buildings shall be hot-dip galvanized in accordance with the requirements of SANS 763 and afterwards painted with the pipework and fittings as specified in the Particular Specification G02: Corrosion Protection.

Suitable plastic sleeves and/or washers shall be used for protection against corrosion by metallic action.

PSHA 5.2.10 Protective treatment

Delete this Sub Clause and refer to the Particular Specification G02: Corrosion Protection.

PSHA 5.2.11 Handrails

Add the following to this Sub Clause:

Stanchions for handrailing shall be of approved prefabricated ball type made in one piece without welding at ball joints to accept the hand and kneerails and shall have adequate baseplates drilled for two No. M 12 bolts at appropriate centres.

Hand and kneerails shall consist of 25 mm nominal inside diameter tubing cut and bent to shape and no welding is allowed at joints. Stanchions shall be spaced not more than 1,5 metres apart. Unless otherwise shown, all handrailing shall be 900 mm above walkway level.

All tubing, stanchions and baseplates shall be manufactured in grade 304 stainless steel or hot dipped galvanized (heavy coating), as scheduled or shown on the drawings.

All stainless steel components shall have a No. 1 surface finish and surfaces shall be pickled and passivated in accordance with the requirements of the Particular Specification G02: Corrosion Protection.

PSHA 5.2.12 Ladders

Ladders shall be of all welded construction completely in accordance with the accompanying sketch. Corrosion Protection shall be carried out in accordance with the requirements of the Particular Specification G02: Corrosion Protection.

Vertical ladders may also comprise tubular stringers at 500 mm centres made of 32 mm nominal bore pipes with wall thickness not less than 3.0 mm. Rungs shall be spaced 300 mm centres and made of 20 mm nominal bore pipes with wall thickness not less than 2.5 mm.

The tubular stringers shall be drilled on one side only to provide a sliding fit for the ends of the rungs which shall protrude through these holes up to the opposite inside face of the stringer and be welded all around where they enter the holes in the stringers.

Lugs for bolting these ladders to walls shall consist of 20 mm nominal bore pipes with wall thickness not less than 2.5 mm. Baseplates for stringers and lugs shall be adequate and drilled for 2 No. M12 stainless steel bolts at appropriate centres.

PSHA 5.2.13 Prefabricated open grid flooring

PSHA 5.2.13 Add the following to this sub clause:

Open grid flooring shall be of square pattern type of approved manufacture with

40 x 4 mm minimum thickness bearer bars spaced at not more than 40 mm centres and shall be manufactured in grade 304 stainless steel or 3CR12 steel (as scheduled or as shown on the drawings). The tendered rate shall include for all cutting into the required panels, banding and for frames detailed below.

Open grid flooring shall be provided with welded frames as scheduled, made of 3CR12 steel or stainless steel as scheduled or as shown on the drawings and with dimensions 50 x 50 x 5 mm thick angle to provide a seating for the flooring. The nett clearance between the side bars of the open steel flooring and the vertical leg of the frame or strip shall be 5 mm per side. The frames shall be complete with 100 x 40 x 3 mm fishtail anchors (of the same material) fixed at 500 mm centres for building the frame into the concrete work.

Pickling and passivation shall be carried out in accordance with the requirements of the Particular Specification G02: Corrosion Protection.

PSHA 5.2.14 Floorplate floors (chequer plates)

Unless otherwise stated on the drawings or schedules, floorplate shall have a thickness of 4.5 mm and shall be of the non slip type.

The floorplate shall be made up as shown on the Drawing complete with handles, hinges and locating angles welded to the underside.

The tendered rate shall include for all cutting into the required panels (and for a frame, should it be described on the drawings or schedules).

Floorplate shall be manufactured in grade 304 stainless steel or 3CR12 steel (as scheduled or as shown on the drawings) and shall be pickled and passivated as specified in the Particular Specification G02: Corrosion Protection.

PSHA 5.2.17 Straps for pipes

Straps for holding down pipes to concrete surfaces shall be manufactured in the material stated on the drawing and to the dimensions as shown on the drawing. If no dimensions or materials are shown, same shall be 50 mm wide by 3 mm thick 3CR12 steel. The strap shall be slotted and shall be fixed to the concrete by means of M10 stainless steel self drilling anchor bolts. The material between the strap and pipe shall be 8 mm thick neoprene sealing material 50 mm wide.

Pickling and passivation shall be carried out in accordance with the requirements of the Particular Specification G02: Corrosion Protection.

SANS 1200 L: MEDIUM PRESSURE PIPELINES

PSL 2 INTERPRETATION

PSL 2.1.2 Supporting Specifications

Add the following to this Sub-Clause:

(h) SANS 1200 HA

PSL 2.4 Abbreviations

Add the following to this Sub-Clause:

FC - Fibre reinforced cement

HDPE - High density polyethylene

PSL 3 MATERIALS

PSL 3.3 Cast Iron Pipes, Fittings And Specials

Add the following to this Sub-Clause:

All cast iron pipes and fittings shall comply with the requirements of BS2035 and unless otherwise specified, shall be of class D quality for straight pipes and of class CD quality for fittings. Material used shall comply with the requirements of SANS 1034 grade 300 for “Grey Iron Castings”.

Before leaving the foundry, all cast iron pipes and fittings shall be protected against corrosion in accordance with the Particular Specification G02: Corrosion Protection.

PSL 3.4 Steel Pipes, Fittings And Specials.

PSL 3.4.1 General

Add the following to this Sub-Clause:

Stainless steel shall be ANSI Type 304L Schedule 10 unless otherwise specified.

PSL 3.4.3 Pipes of Nominal Bore Over 150mm

PSL 3.4.3 (a)

Replace this Sub-Clause with the following:

All pipes to comply with SANS 719 Grade “B” with wall thickness as follows:

Nominal Bore (mm)	Minimum Wall Thickness
200 – 375	4 mm
400 – 550	5 mm
600 – 700	6 mm
750 – 900	8 mm
950 – 1550	10 mm
1800	14 mm

PSL 3.7.2 Polyethylene pipes

Replace this Sub-Clause with the following:

All HDPE pipes and pipe fittings shall comply with SANS ISO 4427. All pipes, fittings and stub ends shall be joined through butt-welding in accordance with SANS 10112 and welding beads shall be removed on the inside only of all butt-welded joints.

PSL 3.8.3 Flanges and accessories

Add the following to this Sub Clause:

Unless otherwise scheduled the dimensions and drilling of standard flanges shall comply with the requirements of SANS 1123 table 16 for pipes and fittings with a diameter of 150 mm and smaller and in accordance with table 10 for diameters exceeding 150 mm. Flanges shall be machined flat, i.e. without a raised joint face. Puddle flanges shall have the same dimensions as standard flanges but shall be undrilled.

Faces of flanges which will be in contact with jointing gaskets shall receive a protective coating similar to the corrosion protection specified for the internal surface of the pipes and fittings of such thickness and consistency as will not impair the air/gas/water tightness of the joint.

The jointing gaskets shall comply with the requirements of BS 3063 and shall be cut to the full width of the flange and holed for bolts.

All threaded bolts shall be coated with a nickel based anti-seize compound before adding the nut.

PSL 3.9 Corrosion Protection

Delete this Clause and refer to the Particular Specification G02: Corrosion Protection.

PSL 3.10 Valves

Delete this Clause and add the following:

a. Gate valves shall be double flanged with non rising spindle and shall be fitted with gun metal seats, bronze spindles and gun metal nuts. The direction of closing, which shall be clockwise when viewed from above, must be clearly indicated on the hand wheel of each valve. Gate valves shall be of standard waterworks pattern complying with the requirements of SANS 664 for working pressures as specified for each application.

b. Reflux valves shall, except where otherwise specified, be Nitrile covered single door swing type and shall be double flanged and mounted horizontally. 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 springs. Reflux valves shall comply with the requirements of SANS 1551-1 for working pressures as specified for each application.

c. Butterfly valves shall be double flanged, double eccentric type and shall conform to the requirements of BS 5155.

- The valve body shall be of spheroidal graphite cast iron, grey cast iron or ductile iron. The valve body shall have integral hubs for housing shaft bearings and seals.

- Valves shall be capable of operating at any opening without variation of disc position or flutter of the disc.

- The profile of the resilient seats shall be smooth and continuous and shall provide adequate “lead in” for the resilient seal during closure of the disc to prevent excessive sealing torque requirements.

- The resilient seals shall have non-weathering, non-sticking, long life properties and shall be fully locked-in, removable and replaceable.

- Valve discs shall be of a single casting, with a streamlined shape, and shall have smooth surfaces.

- Shafts shall be continuous or may be of the stub-shaft type. If of the stub-shaft type, each shaft shall extend into the disc hub for a distance of 1,5 times the shaft diameter.

- Valves shall be capable of opening or closing under an unbalanced pressure equal to the specified working pressure without any difficulty. Closure of valves shall be by clockwise rotation of the handwheel (or

ratchet, where specified for valve diameters of 200 mm or smaller) and shall be suitable for droptight shut-off application.

d. Pinch Valves shall be double flanged and shall be suitable for fitting an electrically operated actuator to the valve if required and shall close in a clockwise direction when viewed from above. The valve body shall be manufactured in S.G. iron in accordance with BS EN 10213-2 grade 680. The sleeve shall be manufactured in neoprene and reinforced with steel cord. The valves shall be suitable for a working pressure as specified for each application.

e. Plug Valves shall be flanged and shall be suitable for fitting an electrically operated actuator to the valve if required and shall close in a clockwise direction when viewed from above.

- Port arrangements shall be as specified for each application. The valve shall be antistatic and the body shall be manufactured in S.G. iron in accordance with BS EN 10213-2 grade 480. The plug shall be manufactured in stainless steel. The body of the valve shall be supplied with two surge connections for cleaning the inside of the valve. The valve shall be suitable for a working pressure as specified for each application.

f. Resilient Seal Gate Valves shall be double flanged with non rising spindle and shall conform to the requirements of SANS 664 for working pressures as specified for each application. Spindles shall be in stainless steel with bronze nuts. The direction of closing, which shall be clockwise when viewed from above, must be clearly indicated on the handwheel of each valve.

g. Air Valves shall have single or double openings as specified and shall be manufactured, when applicable, to the same standards of quality and finish as laid down in SANS 664 for gate valves.

- Each single acting air valve shall incorporate either a large or a small orifice, as specified, and shall be fitted with a detachable copper alloy isolating gate valve.

- Each double acting air valve shall incorporate a large and a small orifice as well as an isolating valve that forms an integral part of the air valve. Such isolating valves shall have bronze or stainless steel spindles fitted with CI cap tops and shall close clockwise.

- The cross sectional area of the orifice openings shall be at least equal to the nominal bore of the air valve.

h. Knife gate valves shall have a solid body casting, and shall be suitable for mounting between flanges or as a terminal valve. The knife gate valve shall have a polished 304 stainless steel gate with chamfered edge at the base.

- The gate shall seal either on a replaceable nitrile O ring or P.T.F.E. seal secured in the body. The seal shall be an internal resilient seal, mechanically retained, to ensure that the blade is guided throughout its travel and that bi-directional drop tight leak proof sealing is obtained.

- Knife gate valves shall be fitted with rising grade 304 stainless steel spindles with non-rising hand wheels. The direction of closing, which shall be clockwise when viewed from above, shall be indicated clearly on the handwheel. The knife gate valves shall comply with the requirements of SANS 664, for working pressures as specified for each application.

i. General: Before leaving the factory valve bodies shall be treated as follows:

Internally: 150 mm diameter and smaller: manufacturer's standard corrosion protection treatment

Internally: larger than 150 mm diameter: as specified in the Corrosion Protection Specification

Externally: as specified in the Corrosion Protection Specification.

PSL 7.4 Tests on Epoxy Coatings

Delete this Clause and refer to the Particular Specification G02: Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction (Golder Associates, 2006 Edition).

PSL 8 MEASUREMENT AND PAYMENT

PSL 8.2.5 Supply and Place Pipes, Valves And Specials

Replace this Pay Item with the following Pay Item:

Supply, testing and installation of pipework, fittings and specials as detailed in the Pipe Schedule of the Schedule of Quantities

Unit: Sum

The tendered sum shall include full compensation for the supply of all material, bolts, nuts and gaskets as described under PSH 3.6.1, manufacture of the pipes, fittings and specials and shall further include for delivery, installation, jointing, testing, holding in position during concrete encasing, blanking off ends to prevent ingress of foreign matter, cleaning out pipes, fittings and specials before connecting up and the full corrosion protection of pipes, fittings and specials as specified in the Particular Specification G02: Corrosion Protection. Testing shall include for the supply of water, testing equipment, blank flanges, pipe plugs and all other items necessary to conduct a successful test.

SANS 1200 LB: BEDDING (PIPES)

PSLB 3.4.1 Contractor Required to Excavate Selectively

Notwithstanding the requirements of Sub-Clause 3.7 of SANS 1200 DB and Sub-Clause 3.4.1 of SANS 1200 LB regarding the use of selective methods of

excavating, the Contractor shall use selective methods of excavating and shall provide and use plant that will enable him to avoid burying or contaminating material that is suitable and is required for bedding.

PSLB 3.4.2 Suitable Material Not Available from Trench Excavation

For this Project freehaul will be regarded as haulage within the boundaries of the Site of the Works as well as 1,0 km outside the boundaries including the access road between the fence lines. This is also valid for Clause LB 8.1.5, LB 8.1.6, LB 8.2.1, LB 8.2.2.2, LB 8.2.2.3 and LB 8.2.5.

PSLB 5.1.2 Details of bedding

Unless otherwise directed on the Drawings or instructed by the Employer's Agent, all pipes shall be laid on Class B bedding.

PSLB 5.4 Concrete Casing to Pipes

Pipes which are to be encased in concrete shall be encased in grade 10/20 concrete to the dimensions as shown on the Drawings or as instructed by the Employer's Agent.

Add the following Sub-Clause:

PSLB 5.5 Draining of Trenches

Where ground water is present to such an extent that, in the opinion of the Employer's Agent, it would hamper the placing and consolidation of the fine granular bedding or the placing of the concrete bedding in the bottom of the trench, as the case may be, or would cause buoyancy of the pipes, the Employer's Agent may order the provision of a drain in the bottom of the trench to assist in dewatering during construction and until the trench has been backfilled to such an extent as to prevent buoyancy of the pipes.

The drain ordered will be as shown in the sketches of Types 1, 2, 3 and 4 Subsoil Drains attached.

At certain points along the trench, depending upon the amount of water to be handled, sumps shall be formed from which the water may be pumped to prevent a build up of water in the trench to a level above that of the top of the layer of stone forming the underdrain.

The stone in the underdrain shall consist of nominal 40 mm crushed stone complying with the grading as specified for 'Stone for Concrete' in Table 5 of SANS 1083 (as amended 1979) and shall be well compacted to provide a uniform support for the pipe bedding to be placed on top of it.

Before placing the granular bedding or the concrete bedding the underdrain shall be covered with an approved non-woven polyester geofabric of at least 210g/m² to prevent ingress of granular material or mortar into the interstices of the underdrain.

Add the following pay item:

SANS 1200 LC: CABLE DUCTS

PSLC 8 Measurement and Payment

PSLC 8.2.9 Overhaul of surplus excavation

Add the following Sub-Clause:

For this Project freehaul will be regarded as haulage within the boundaries of the Site of the Works as well as 1,0 km outside the boundaries including the access roads within the fence lines.

SANS 1200 LD: SEWERS

PSLD 5 CONSTRUCTION

PSLD 5.2 LAYING AND BEDDING

Add the following Sub-Clauses:

PSLD 5.2.5 Reinforced concrete pipes:

Where concrete pipes are laid between structures, manholes or junction boxes, laying of pipes shall commence at the manhole or junction box at the lower end of the pipeline with full length pipes with the last pipe cut to form a closure piece for building into the structure, manhole or junction box at the upper end of the pipeline. Only the last pipe at the upper end of the pipeline shall be cut to avoid problems with jointing.

PSLD 5.2.6 FC pipes:

Where Fibre Cement (FC) pipes are laid between structures, manholes or junction boxes, laying shall commence at the lower end of the line with a short length (500 mm or 2.5 times the internal diameter of the pipe, whichever length is longer – with both ends machined to suit a flexible coupling), and thereafter by full length pipes with the last pipe cut so as to form the closure piece in the line as at the lower end of the line.

PSLD 5.2.7 Cut pipes:

In the case of concrete pipes, after the cut end has been finished off it shall be painted with two coats of bituminous paint to provide protection to the exposed ends of the reinforcing steel in the pipe.

In case of FC pipes, the cut ends shall be machined to the correct outside diameter with appropriate tools. All work performed on the cut ends shall be done to the satisfaction of the Employer's Agent.

PSLD 8 MEASUREMENT AND PAYMENT

Add the following pay items:

PSLD 8.3 Building Pipes into Brickwork

a. Pipes supplied and installed by the Contractor (irrespective of type)

i. (state diameter of pipe) **Unit: Number (No)**

ii. (etc. for other diameters) **Unit: Number (No)**

The unit of measurement shall be the number of pipes built into the concrete work as shown on the drawing.

The tendered rate shall include full compensation for supplying all materials (wet to dry epoxy in the case of casting new concrete against the faces of old concrete) concreting in the pipes, cutting and placing formwork to fit around pipes and neatly finishing to conform to a smooth surface finish.

In the case of the Contractor building in his own pipes the rate shall also include for holding the pipe in position and aligning the pipes to the correct levels as indicated on the drawing or as ordered by the Employer's Agent.

PSLD 8.4 Supplying and Building High Density Polyethylene (HDPE) Or UPVC Pipes as Specified In Sans 1200 LF Into Brickwork (For Cable Sleeves Or Pipe Sleeves)

a. State material, diameter and class **Unit: Metre (m)**

b. Etc. for other diameters **Unit: Metre (m)**

The unit of measurement shall be the linear metre of pipe installed.

The tendered rate shall include full compensation for supplying, fixing and building in of pipes. The rate shall further include for 2,5mm diameter draw wires in stainless steel and for cutting ends to the required levels for installation of cables by the Electrical Contactor or after installing pipework through ducting. The ends shall be closed with end caps to prevent ingress of rubbish and water.

PSLD 8.5 Extra Over Item LD 8.2.1 For Cutting and Painting Ends Of Concrete Pipes To Form Closure Pieces In The Pipeline (Measured Per Cut End)

a. For type or class of pipe, state diameter **Unit: Number (No)**

b. etc. for different class or types of pipes, state diameters

Unit: Number (No)

The unit of measurement shall be the number of cut ends in the pipeline. The tendered rate shall include full compensation for the cutting of the pipe, including trimming of cut ends, pipe wastage and supplying and applying two coats of bituminous paint to cut ends to protect the reinforcing steel against corrosion.

SANS 1200LE: STORMWATER DRAINAGE

PSLE 1 SCOPE

PSLE 1.1 Add the following:

This specification covers all the work in connection with the construction of subsurface drains and drainage blankets at the locations and to the size, shapes, grades and dimensions as shown on the Drawings or as directed by the Employer's Agent.

PSLE 3 MATERIALS

PSLE 3.5 Geofabric Blanket

Delete this Sub Clause and refer to Sub Clause PSLE 3.7(c).

Add the following Sub Clauses:

PSLE 3.6 Pipes

a. Pipes for subsurface drains shall be one of the following types as specified:

b. Perforated HDPE pipes which comply with the requirements of DIN 4262 Part 1.

c. Perforated or slotted unplasticised PVC pipes which comply with the requirements of SANS 791.

d. Porous concrete pipes which comply with the requirements of BS 1194.

e. Vitrified clay pipes which comply with the requirements of SANS 559 (excepting the requirement regarding nominal diameter) and which have special joints intended for subsoil drains may be specified or used if the Employer's Agent's approval is obtained in advance, provided that, where the gaps at the joint do not conform to the requirement for the slots specified below, the grading of the permeable material shall be suitable adapted to meet the design requirements for preventing permeable material from entering the pipe.

The size of 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 fewer than 26 for 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced evenly in two rows for 100 mm pipes and in four rows for 150 mm pipes.

Slotted pipes shall have a slot width of 8 mm with a tolerance of 1,5 mm in width. The arrangement of slots shall be subject to the Employer's Agent's approval, but the total slot area shall not be less than that specified for perforations.

Pipes without slots or perforations required for transporting subsoil water from the subsoil drain proper to the point of discharge shall be unperforated pitch fibre of PVC pipes of the types specified above, or concrete pipes which comply with the requirements of SANS 677 Class A.

PSLE 3.7 Permeable Material

Sand, crushed stone and geotextiles used as permeable filter materials for subsurface drains and drainage blankets shall conform to the following requirements:

a. Sand

Sand shall be clean, hard washed river sand obtained from approved sources. The grading of the sand shall be subject to the Employer's Agent's approval. The requirements in respect of each type and the comparative prices of sand from the available sources will determine which source is to be used. The

Contractor shall submit samples and prices from available sources when so instructed by the Employer's Agent.

b. Crushed stone

Crushed stone shall be clean, hard, durable crushed stone from approved sources. The aggregate crushing value of the stone shall not exceed 30 when tested in accordance with method B1 of TMH1.

i. Crushed stone for graded filters

Crushed stone for graded filters shall conform to the grading requirements set out below:

Grade	Sieve size (mm)	Percentage passing by mass
Fine grade	26,5	100
	13,2	60 - 85
	3,35	15 min
	1,18	15 max
Coarse grade	26,5	100
	13,2	60 - 85
	6,70	15 min
	2,36	15 max

The aggregate shall be evenly graded between the coarse and fine fractions with no undue discontinuities. The Employer's Agent shall indicate the grade of stone required.

ii. Crushed stone for filters which incorporate geotextiles

Crushed stone for filters which incorporate geotextiles shall be nominally sized stone which conforms to the grading requirements of SANS 1083, or crushed stone which complies with the grading

requirements for graded filters. The Employer's Agent shall indicate the type of stone to be used in each particular case.

c. Geotextiles

Geotextiles shall be a non woven, spun or thermic bonded continuous filament fabric consisting of at least 85% by mass of poly propylene, polyester or other approved material and manufactured for civil engineering applications by a recognized manufacturer. The brand and type of geotextile to be used shall be as specified in the Project Specifications or on the Drawings or as directed by the Employer's Agent.

PSLE 3.8 Polyethylene Sheeting

Polyethylene sheeting shall be black in colour with a minimum thickness of 0,15 mm and manufactured by a recognized manufacturer.

PSLE 5 CONSTRUCTION

PSLE 5.2.4 Pipes With Open Joints Laid With Geofabric Blanket Wrapping

Delete this Sub Clause and refer to Sub Clause PSLE 3.6.

Add the following Sub Clauses:

PSLE 5.8 Graded Filter Drains

After the completion of the excavations, the bottom portion of the trench shall be lined with polyethylene sheeting as shown on the Drawings. The top edges of the vertical portions of the sheeting shall be tacked to the sides of the excavation with nails or by any other suitable approved means. The sheeting shall be heat welded at the laps. Sheeting damaged during installation or construction shall be replaced at the Contractor's cost.

A layer of permeable material of the class and thickness as shown on the Drawings shall be placed on the polyethylene sheeting on the bottom of the

trench and shall be lightly tamped and finished to the required gradient to serve as a bedding for the pipes.

Pipes of the type and size required shall then be firmly bedded in the permeable material, true to level and grade, and shall be coupled where required. Where spigot and socket pipes are used, the socket ends shall be laid upgrade with the spigot fully entered into the adjacent socket. Where plain butt ended pipes are used, they shall be laid firmly together to prevent the infiltration of backfill material. Perforated and slotted pipes shall be joined by couplers. Perforated pipes shall be laid with the perforations at the top unless otherwise shown on the Drawings or instructed by the Employer's Agent, in writing. The higher end of a subsurface drain pipe shall be sealed off with a loose concrete cap, and at the lower end the pipe shall be built into a concrete headwall to provide a positive outlet, or it shall be connected to stormwater pipes or culverts, all as shown on the Drawings or as directed by the Employer's Agent.

Successive layers of permeable material shall be placed after the pipes have been laid. Permeable material shall be placed in layers not exceeding 300 mm at a time, and shall be lightly compacted. The total thickness of each type of permeable material shall be carefully controlled by means of spacers. When successive layers are placed, the lower layer shall not be walked on and shall, as far as is possible, not be disturbed. Care shall be taken to prevent the contamination of permeable material during construction of the subsurface drains, and all permeable material contaminated by the soil or silt shall be removed and replaced by the Contractor at his expense. Care shall also be taken at all stages not to perforate or otherwise damage the polyethylene lining.

The remainder of the trench shall be immediately backfilled with approved impermeable material preferably obtained from the excavations, in layers not exceeding 100 mm and compacted to 90% of modified AASHTO density, unless otherwise ordered by the Employer's Agent. The trench must 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 from pipes without perforations or slots shall be backfilled with impermeable backfill material as described above.

PSLE 5.9 Filter Drains Which Incorporate Geotextiles

After the completion of the excavations, the bottom portion of the trench shall be lined with geotextile sheeting as shown on the Drawings. The top edges of the vertical portions of the geotextile sheeting shall be tacked to the sides of the excavation 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.

The specifications set out in PSLE 5.8 above for the construction of the pipe bedding, the pipe laying, and the placing of the crushed stone filter materials for graded filter drains shall apply mutatis mutandis to filter drains which incorporate geotextiles.

After the pipes have been laid and the specified layer of crushed stone filter material has been completed, 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 sheeting. An overlap of at least 200 mm shall be provided between the portions folded back.

The specifications set out in Sub Clause PSLE 5.8 above shall apply mutatis mutandis to the placing of the remaining layers of permeable material and the top layer of impermeable material, all as shown on the Drawings or ordered by the Employer's Agent.

PSLE 5.10 Drainage Blankets

Drainage blankets shall be constructed in accordance with the details shown on the Drawings. Firstly geotextile sheeting shall be laid on top of the layer on which the drainage blanket is constructed. Then permeable material of the type specified shall be spread on the geotextile sheeting to the specified depth. The Contractor shall take care not to damage the geotextiles. The permeable material shall be lightly compacted and finished to the required level. To complete the drainage blanket, geotextile sheeting shall be laid on the layer of permeable material.

The layers on top of the drainage blanket shall be constructed in such a manner that the permeable material or the geotextile sheeting will not be displaced or damaged. Normally material which is to be compacted on top of the drainage blanket shall be watered and mixed before it is placed on the blanket. It shall then only be necessary to level and compact the material on the blanket.

PSLE 8 MEASUREMENT AND PAYMENT

Add the following pay items:

PSLE 8.2.17 Pipes In Subsurface Drains

(a) (Type of pipe indicated) complete with couplings:

(i) 110mm diameter perforated uPVC pipe **Unit: Metre (m)**

(ii) etc. for other diameters **Unit: Metre (m)**

(b) (Type of fitting indicated)

(i) (diameter indicated) **Unit: Number (No)**

(ii) etc. for other diameters **Unit: Number (No)**

(c) Etc. for other types of pipes

(d) Etc. for other types of fittings

The unit of measurement for pipes shall be the metre of pipe, measured in place along its centre line, including the length of fittings. The unit of measurement for fittings shall be the number of fittings, irrespective of the type.

The tendered rate shall include full compensation for the supply and construction of the pipes and fittings as specified.

PSLE 8.2.18 Polyethylene Sheeting

(State thickness or an equivalent approved material, for lining subsurface drains) Unit: Square metre (m^2)

The unit of measurement shall be the square metre of polyethylene sheeting installed, measured net from the specified dimensions.

The tendered rate shall include full compensation for the supply and construction of the sheeting as specified.

NOTE: For items PSLE 8.2.14 to PSLE 8.2.17 excavations for subsurface drains shall be measured in accordance with SANS 1200D or SANS 1200DB where applicable.

SANS 1200 LG: PIPE JACKING

PSLG 5.1.1 Authority to Jack Pipeline under Facilities Controlled by Third Parties

Add the following:

The Contractor shall be bound by and shall observe the requirements and/or conditions imposed by the service provider in granting any such permission as specified. Although the general supervision and control of the Works falls under the authority of the Employer, the service provider reserves and shall have the right to instruct the Contractor directly in any matter that has a direct bearing on the safety of the service and the protection of the interests of the service provider.

PSLG 5.6 Backfilling and Disposal of Excavated Material

Add the following Sub-Clause:

The thrust and reception pits shall be backfilled with material obtained from the pit excavations. Hard and rock material shall be incorporated in the backfill only to the extent approved by the Employer's Agent. Depending on the quality of the material, the Employer's Agent may direct that it be mixed with other backfill material.

If, in the opinion of the Employer's Agent, insufficient or no suitable material is available for this purpose within the freehaul distance, and the shortage of such material has not been caused by the methods used by the Contractor, the Employer's Agent may instruct the Contractor to import sufficient suitable material. The Contractor shall so arrange his work that the importance of backfill material is kept to a minimum in respect to both quality and overhaul.

PORTION 3: PARTICULAR SPECIFICATION

PSU: BUILDER'S WORK

PSU 1 SCOPE

This section covers the various construction activities associated with the erection of buildings which form part of certain civil projects.

Building work shall be carried out in accordance with the National Building Regulations and the information contained in this section.

Work appurtenant to the erection of buildings such as earthworks, concrete work, structural steelwork, etc. shall be carried out as specified in the appropriate sections of these specifications and will be measured and paid for under those sections.

PSU 2 INTERPRETATION

PSU 2.1 Supporting Specifications

The following specifications shall, inter alia, form part of the Contract Document:

(a) SANS 1200A

(b) SANS 1200D

(c) SANS 1200G

(d) SANS 1200HA

(e) Particular Specification G02: Corrosion.

PSU 3 MATERIALS

PSU 3.1 BRICKWORK, PLASTER WORK AND FLOOR SCREEDS

a. Bricks

Bricks shall comply with SANS 227 and shall be classified according to their intended use as defined below.

Engineering bricks in both the clay and cement categories shall be durable and selected for their uniformity of dimension, with a minimum average strength of 25 MPa. These bricks shall be free from cracks, chips or defects.

Face bricks shall not require any further decorative treatment and shall be selected for their uniformity of dimension, colour and texture, with a minimum average compressive strength of 25 MPa. These bricks shall be of clay, and shall be pressed or wire cut and free from chips, cracks, stones or other defects. Water absorption shall not exceed 5 %. Special care shall be taken in the loading, stacking and handling of face bricks, as no damaged bricks may be used.

Stock bricks shall be suitable for general building work and shall have a minimum compressive strength of 15 MPa. The water absorption of stock bricks shall not exceed 10 %.

Satisfactory proof of the load bearing capacity of the bricks offered shall be submitted before deliveries are made to the Site.

Air bricks shall be well burnt terracotta and shall be free from cracks and blemishes and lined with copper mosquito gauze.

Three samples of each type of brick shall be submitted to the Employer's Agent for approval prior to the delivery of the bricks concerned. All subsequent deliveries shall be of a standard equal to or better than that of the approved samples.

b. Wall ties

Wall ties shall be of the galvanized, crimped, single wire type with a 3,5 diameter, and shall comply with the requirements of SANS 28.

c. Damp proof sheeting

Damp proof sheeting shall comply with SANS 248, type FV for fibre felt, or SANS 952, type B for embossed polyethylene sheeting.

d. Masonite

Masonite used for roof bearings on top of brick walls shall be 3 mm thick approved tempered masonite.

e. Roof bearings

Commercial roof bearings used on top of brick walls shall (unless otherwise stated) consist of an approved neoprene core protected with approved polyethylene sponge both sides, rated at 40 kN/m and which allows horizontal movement less than 2 mm.

PSU 3.2 Ironmongery

a. General

All steel and iron work shall be delivered clean and free from rust, pitting or other defects. Shop priming's shall be applied before delivery and shall consist of a coat of red oxide paint, or any other approved anti rust paint on all surfaces.

Unless otherwise specified, all materials shall conform at least to the appropriate SANS or BS standards where such standards apply to ironmongery, steel, cast iron or any other related materials.

b. Pressed Steel Door Frames

Pressed steel door frames shall comply with SANS 1129 and shall be manufactured from 1,6 mm thick mild steel sheeting, pressed to the required shapes, properly mitred, welded and reinforced, with all welding neatly cleaned off.

Frames shall be of the widths required to suit the thickness of the walls into which they are built and shall be fitted with suitable tie bars and braces at the bottom. Three lugs to be built into the brickwork shall be provided on each jamb.

Rebates in frames and transoms for doors shall be of the widths required to suit the thicknesses of the doors and shall be fitted with a pair of approved steel butt hinges set flush into recesses in the frames. 4,5 mm thick reinforcing plates shall be welded to the backs of the frames at hinge positions.

Heads of frames over double doors shall be drilled where required to form keeps for bolts and shall be fitted with one rubber buffer for each leaf of the door.

Frames for single doors shall be fitted with approved chromium striking plates and adjustable striking plate keeper boxes in at the back of the frame by a welded on sheet metal box. The frames shall be fitted with a minimum of two rubber buffers.

Frames shall be protected against twisting and damage during transit and erection.

c. Pressed steel doors

Pressed steel doors shall be manufactured from 1,6 mm thick steel plate. The doors shall be of standard design, pressed to shape with 40 mm reveals all round. The doors shall be strengthened with full length vertical V shaped or other approved sectional strengthening ribs projecting to the outer face. Two horizontal stiffening rails shall also be welded to the inner face of the doors.

A door shall be hung on a pair of 100 mm long steel butt hinges with loose pins. The leaves of the hinges shall be welded to both the door and the door frame, and a 1,6 mm thick steel plate shall be welded to the inner face of the door to protect the lock.

One leaf of double doors shall be fitted at the top and bottom with approved 150 mm cast brass barrel bolts in an approved manner and the other leaf shall be fitted with a lock, the striking plate of which shall be fixed to the first leaf.

Where indicated on the Drawings, doors shall be fitted with louvered ventilation grills of approved design, backed with insect and vermin proof gauze screening.

d. Steel window frames

All steel window frames shall comply with SANS 727 and shall be of the types and sizes shown on the Drawings.

Standard industrial types of steel window frames shall be constructed from rolled mild steel industrial sections, 35 mm wide by 3 mm thick, with opening sections constructed from standard residential sections, 25 mm wide by 3 mm thick, welded at angles and properly jointed at intersections.

Window frames shall be formed perfectly flat, truly square and properly jointed at all angles, and the opening portion shall fit properly on all faces and shall open and close freely.

Glazing bars shall be continuous with jointed intersections, the ends being neatly tenoned into the frame and securely welded in position.

Frames shall be fitted with standard fixing lugs.

Opening sections shall open as indicated on the Drawings, and shall be fitted with steel hinges with brass pins. Pivots shall be fitted with bronze ring centres.

Side hung or top hung opening sections shall be fitted with brass handles and friction stays. Bottom hung sections shall be fitted with friction pivots and spring catches.

Weather bar drips shall be attached to the fixed frames for the complete width of the window at the head of outward opening sections.

Composite windows may either be delivered completely assembled with mullions and transoms or as separate units for assembly on the Site, but "one piece" construction is preferred.

e. Burglar proofing for steel window frames

Burglar proofing for steel window frames shall be constructed from rolled mild steel rods of at least 12 mm diameter and welded at all intersections to form openings not exceeding 125 mm by 250 mm.

Burglar proofing sections shall be formed perfectly flat, truly square where applicable and properly welded onto the window frame in such a manner that it does in no way prohibit the opening/closing of windows nor the cleaning of window panes.

Burglar proofing shall be welded/fixed to the window frame prior to the building in of the frame.

f. Door locks and handles

All door locks shall comply with the requirements of SANS 4 and shall be of approved manufacture and pattern. All locks shall be supplied with two keys. Keys shall be distinctly numbered with consecutive numbers and each key shall be stamped with the same number as that of the lock which it controls. No two locks in any one building may have the same key.

External doors shall be fitted with three lever heavy duty mortice locks, which shall be master keyed.

All locks shall be properly installed and, after completion, striker plates shall be adjusted and the locks serviced.

Door handles shall be of cast zinc of approved manufacture and pattern.

g. Miscellaneous fittings

All retaining devices for doors and windows as well as fittings such as coat hooks, retaining hooks, etc. shall be of solid brass. All fittings shall be secured by screws or set screws of the same material and finish as the fitting.

Fittings to be fixed to plastered walls, masonry or floors shall be fixed direct by means of patent plastic or fibre plugs fitted into drilled holes.

Doorstops shall be provided at every door and shall be 40 mm diameter rubber stops.

h. Valves

All water taps, other than those for special hospital and similar fittings, and stop taps shall comply with the requirements of SANS 226.

Ball valves shall comply with the requirements of SANS 752.

Non swinging rotary fire hose reels shall comply with the requirements of SABS 543 with solid discs and a 25 mm waterway at the brackets. They must incorporate a Jennkin's type control valve and a rotary pressure joint at hub to hose connection. Valve handwheels are to be clearly marked with a arrow and "Open" in red.

All reels are to be fitted with the specified length of 19mm internal diameter first quality 4 ply canvas reinforced red rubber hose having a smooth black rubber core or with another equal type of hose to the approval of the Employer's Agent and the local Fire master. The hose must be firmly fixed at one end to the reel hub connection and must be so arranged that the hose coils without kinking at the joints. It must be fitted at the other end with chromium plated 19mm metal shutoff cock and an 8mm detachable nozzle. A suitable chromium plated flexible hose guide through which hose is to be permanently threaded is to be provided and securely fixed to the wall and is to be near the reel in a way which will allow the hose to be run out in any direction. A suitable chromium plated bracket is to be provided for supporting the nozzle when the hose is not in use.

PSU 3.3 Glazing

a. Glass

Glass shall comply with the requirements of CKS 55. The quality of all window glass shall be such that surface deterioration will not develop after glazing.

All glass shall be free from bubbles, waviness, scratches, stains or other imperfections.

Unless otherwise specified, sheet glass for glazing shall be flat drawn clear glass of ordinary glazing quality and of the thicknesses indicated below.

For panes not exceeding 0.75 m in area: 3 mm.

For panes exceeding 0.75 m but not exceeding 1,5 m in area: 5mm.

b. Putty

All putty shall comply with the requirements of SANS 680.

Putty shall not be too hard or soft or caked when used and shall dry evenly without crazing or cracking.

Defective putty shall be cut out and replaced by the Contractor at his own expense, and any broken glass shall also be so replaced and putty so repainted.

PSU 3.4 Carpentry and Joinery

a. Materials

All timber used for structural purposes shall be of merchantable grade and shall comply with the requirements of SANS 563 and SANS 1245. Structural timber shall be carefully selected and of the best quality, free from large or dead knots, shakes, waney edges or other defects. Purlins, battens (for roof tiles) and brandering shall comply with the requirements of SANS 653. Finger jointed structural timber shall comply with the requirements of SANS 096 and laminated timber with the requirements of SANS 1089.

Hardwoods and softwoods for joinery shall comply with SANS 1099 and SANS 1359 respectively and suitable species shall be used for the various purposes.

Unless otherwise specified, all materials shall conform to the appropriate SANS or BS specification where such standards exist for nails, screws, bolts, adhesives, etc.

b. Preservative treatment

All structural timber shall be given a preservative treatment suitable for the duty for which the timber is intended in accordance with SANS 05, and no untreated timber shall be used. The preservative treatment shall not impair the final finish. The timber shall be impregnated throughout. When surface coating is specified, the compounds applied on the surfaces of the timber shall form an unbroken film.

c. Priming

The jointing surfaces of all joints exposed to the weather and built in portions of frames shall be thickly primed except where adhesives are specified.

Carpentry and joinery items which are prepared for painting by the manufacturer shall be knotted and primed before being dispatched to the Site.

Primes surfaces shall be touched up where necessary during the progress of the work or where Site adjustments have been made.

PSU 3.5 Roof Covering and Accessories

a. Roof covers

i. Galvanized steel sheeting

Unless otherwise stated, galvanized steel sheeting shall have a minimum ungalvanized thickness of 0,5 mm and shall be of the profile as scheduled or shown on the Drawings. The sheeting shall comply with the requirements of an approved manufacturer's specification. The galvanizing shall comply with the relevant requirements of SANS 934 for class Z 600 coating and shall have been passivated.

ii. Fibre cement sheeting

Fibre cement sheeting shall have a minimum thickness of 5 mm, shall be of the profile as scheduled or shown on the Drawings, and shall comply with the relevant requirements of SANS 685.

iii. Roofing tiles (clay and concrete)

Clay roofing tiles shall comply with the requirements of SANS specification 632, and shall be of approved pattern, free of cracks, crazing, chips, twists and other defects, of a uniform colour and equal to the sample submitted to and approved by the Employer's Agent.

Clay tiles shall be approximately 381 mm x 230 mm, weighing 2,95 kg per tile and laid to a gauge to give a coverage of 17,8 tiles to the square meter.

Concrete roofing tiles shall comply with the requirements of SANS Specification 542 and shall be of approved pattern and colour, free of cracks, crazing, chips, twists and other defects, uniform in colour and equal to a sample submitted to and approved by the Employer's Agent.

Concrete tiles shall be approximately 420 mm x 330 mm weighing 4,8 kg and shall be laid to a gauge to give a coverage of 10,25 tiles to the square meter.

Unless otherwise specified, concrete tiles shall have a natural stone granular finish.

iv. Roofing underlays

Roofing underlays for tiled roofs shall either be reinforced bitumen felt complying with BS747 type 1F or polyethylene sheeting complying with SANS 952 type C with a minimum thickness of 0,25 mm.

b. Fasteners

Fasteners and washers shall comply with the requirements of SANS 1273, shall be durable, and shall be protected against corrosion to a standard at least equal

to the standard of corrosion protection of the sheeting material with which they are to be used. Fasteners to be used with fibre cement sheeting shall be hot dip galvanized fasteners and nails for roof tiles shall be made of copper, aluminium or stainless steel.

Bolts and rivets used with galvanized sheeting shall be at least 4 mm in diameter, and those used with fibre cement sheeting, at least 6 mm in diameter. Nails for roof tiles shall be at least 2,8 mm thick and of sufficient length to penetrate the batten by 25 mm.

Self-tapping screws and blind rivets may be used for side stitching and as fasteners for ridging, flashings, etc.

c. Rainwater goods and flashings

Rain water goods such as launders, gutters, down pipes, etc. and flashings shall be of the size and materials as scheduled or shown on the Drawings, and the materials shall, if similar, comply with the same requirements as specified for the sheeting. All rain water goods shall be supplied complete with adequate quantities of suitably shaped brackets and fasteners.

d. Sealants

Sealants shall comply with the requirements of SANS 110, SANS 1254 or SANS 1305 as applicable or with the sheeting manufacturer's recommendations as approved by the Employer's Agent.

e. Battens

Battens for tiled roofs shall comply with clause PSU 3.4(a) and shall be of size 38 x 50 mm.

PSU 3.6 Wall and Floor Tiles

a. Wall tiles shall be 'first grade' glazed ceramic tiles complying with the requirements of SANS 22 for class E tiles and shall be true and regular in shape and size and of even colour.

b. Quarry tiles shall be the best quality pressed tiles, sound, well burnt, even in size and colour and free of markings, hollows, cracks and chips.

PSU 3.7 Waterproofing of Concrete Roofs

Waterproofing material for concrete roof slabs shall be an approved synthetic membrane such as a multiple layer polyester reinforced acrylic membrane or other approved material capable of being fusion welded at joints to provide a homogeneous layer over the whole roof area. The membrane must be capable of withstanding extreme climatic conditions. It shall furthermore be biologically neutral, resistant to ultraviolet rays and heat, compatible with bitumen and be of a thickness of not less than 1.5 mm.

PSU 3.8 Paint

Refer to the Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction (Golder Associates, 2006 Edition).

PSU 4 PLANT

Not applicable to this Section

PSU 5 CONSTRUCTION

PSU 5.1 Brickwork, Plaster Work and Floor Screeds

PSU 5.1.1 Construction of brickwork

a. Cement mortar

Cement mortar shall, unless otherwise specified, consist of 1 part of Portland cement to 4 parts of sand by volume for normal brickwork and 1 part of Portland cement to 3 parts of sand by volume for reinforced brickwork. The ingredients for cement mortar shall be measured in proper gauge boxes on a boarded platform and thoroughly mixed. Alternatively, mixing may be by means of an approved mechanical batch mixer. Only when the dry ingredients have been thoroughly mixed and a mixture of uniform colour has been obtained may the

water be added in sufficient quantity to obtain mortar with the required consistency.

Cement mortar shall be used within two hours of adding water to the mix and shall not be used after two hours or if it has begun to set. Mortar shall be turned over frequently until it is used to prevent it from setting.

b. Brickwork

Dimensions of all the brickwork shall be set out and built as shown on the Drawings. Bricks shall be kept wet before laying and the top of brickwork shall be wetted before any further bricks are laid. Bricks shall be well buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints to faced brickwork shall be neatly made and key drawn with a 6 mm key.

Brickwork shall be carried up in a uniform manner with no portion being raised more than 1 m above an adjacent portion. All perpends, quoins, etc. shall be kept strictly true and square and the whole properly bonded together.

Unless otherwise stated, brickwork shall be built in stretcher bond and bats shall not be used except where required for the bond. All joints shall be 10 mm wide and four courses shall measure 340 mm.

Brickwork for cavity walls and solid walls built in stretcher bond shall be tied with wall ties placed not more than one metre apart in every third course, and shall be staggered vertically or as otherwise specified in the Project Specifications. At openings, the ties shall be positioned not more than 300 mm apart along the periphery of the opening and 150 mm from the opening.

Face brickwork shall be kept perfectly clean. Cavities in cavity walls shall be free of any rubble. Soiled brickwork shall be cleaned at the Contractor's expense, and the cleaning method shall be approved by the Employer's Agent.

c. Reinforced brickwork

Brickwork over door and window openings shall be reinforced with steel rods, welded or expanded mesh, etc. Reinforcement shall be placed in each course of brickwork for a minimum of 4 courses or as shown on the Drawings. Reinforced brickwork shall continue at least 300 mm on each side of the openings.

Brick lintels are to be formed of good, sound well-burnt bricks properly bonded longitudinally. They are to have a bearing of at least 330mm on each side of the opening. Where two openings are less than 1 000mm apart that lintels shall be continuous over all the openings and their dividing piers and also have at least 330mm bearing at both extreme ends. At each reveal the end bricks of the bottom course must have bearing of at least half its face length.

The number of courses in each lintel shall be at least the number of courses stated in the table below. In continuous lintels, the height shall be for the widest opening spanned. The space between the brick skins of the bottom two courses of lintels in cavity walls is to be filled in with concrete made with small aggregate. The bricks are to be bedded and jointed in 3:1 cement mortar. Particular care must be taken to ensure solid bedding, particularly where the reinforcement occurs.

Each lintel is to be reinforced with lengths of approved brick reinforcement in single layers to the full length of the lintel as set out in the table below. Brick reinforcing must be placed in the bottom courses. All brick lintels must be built upon approved rigid temporary supports left in position for at least 7 days after the lintel is completed.

Width of Opening	Thickness of Wall	No. of Brick Courses	Brick Reinforcement

Not Exceeding 1 500mm	115mm 230mm or 280mm	4 4	1 Run 82mm wide in each of 2 joints 1 Run 158mm wide in each of 2 joints
1 500mm to 2 250mm	115mm 230mm or 280mm	6 6	1 Run 82mm wide in each of 4 joints. 1 Run 158mm wide in each of 4 joints
2 250mm to 3 000mm	115mm 230mm or 280mm	8 8	1 Run 82mm wide in each of 6 joints. 1 Run 158mm wide in each of 6 joints

Reinforcement of other diameters and strengths may be used providing the values used are equivalent to those shown in this table.

Prestressed concrete lintels may be used where approved by the Employer's Agent. Prestressed lintels are to be as manufactured and supplied by an approved manufacturer, in the appropriate widths and in the lengths to provide a minimum bearing of 225mm each side of opening. Care must be taken to avoid breakages in handling.

d. Key for plaster

Joints of all brickwork receiving plaster shall be raked out, or the brick surfaces shall otherwise be prepared with an acrylic slurry or any other approved bonding agent.

e. Damp proofing

A damp proof course shall be laid over the full width of all the walls at a minimum height of 150 mm above the final ground level or wherever else it may be required, and it shall be lapped for at least 150 mm at angles and joints. A damp proof course shall also be laid and stepped up under all external sills.

f. Roof bearings on top of brick walls

Top of brick wall shall be properly finished with a 10 mm thick mortar layer with steel float finish and the bearing positioned securely on the centre of the wall. Should the bearing consist of two layers of masonite, the smooth faces of the masonite should each be covered with a thin layer of approved grease and stuck together to form a sliding bearing.

g. General

Rough and fair cutting shall be performed as required, and the brickwork shall be fitted around any steel work. Face brickwork shall be carefully cut and fitted to suit fittings.

Chases shall be left or formed for edges of concrete floors, staircases, etc. Chases shall also be provided wherever they may be required for pipes, conduits, switch boxes, distribution boards, and the like. Joints shall be raked out for flashings.

PSU 5.1.2 Plaster work

a. A plastered finish may consist of a combination of one or more of the following:

   i. A single coat or first coat, comprising one application of a 1:6 cement : sand mixture with a wood or steel float finish.

If a first coat, the plaster shall be wood floated and then scratched, raked or otherwise roughened to provide a mechanical key for the second coat, which shall be applied within 24 hours. Should it be impossible to apply the second

coat within 24 hours, the first coat shall be kept moist until the second coat is applied.

ii. A second coat comprising one application of a 1:6 cement : sand mixture with a wood float finish.

iii. A finishing coat comprising a 1:1½ gypsum : sand mixture with a steel float finish.

b. Thickness

The total thickness of the plaster finish shall be 10 mm minimum and 20 mm maximum.

c. Workmanship

All plaster work shall be finished smooth and ready to receive paint. Plaster shall be flush with the faces of all switch and plug boxes, the interiors of which shall be kept free from plaster. Plastered surfaces shall be plumb and jambs and reveals shall be formed square.

The plasterer shall cut out and make good all cracks, blisters and other defects and leave the plaster work, on completion, in a state which is acceptable to the Employer's Agent

PSU 5.1.3 Floor screeds

a. Normal screeds

Normal screeds shall have a mix proportion by mass consisting of 1 part of Portland cement and 3 parts of fine aggregate. A minimum amount of water is to be used but it shall be sufficient to allow adequate compaction and activation of cement.

Screeds shall be laid on clean hardened bases, prepared as for granolithic screeds, and shall be steel trowelled to a true and smooth finish. Joints in screeds shall coincide as nearly as possible with joints in the bases. The

thickness of screeds shall be as shown on the Drawings or as directed by the Employer's Agent.

The entire screed surface shall be free from loose or raised particles of aggregate, trowel marks or from any irregularities, humps or depressions exceeding 5 mm when measured from a 3 m long straight edge.

Screeds shall be cured for 3 to 7 days as may be directed by the Employer's Agent, and shall be protected from damage.

No moisture sensitive floor finish shall be laid on screeds unless a reliable moisture test shows that the screed is sufficiently dry to receive the covering.

b. Granolithic screeds

Granolithic floor screeds shall be composed of 2 parts of Portland Cement to 3 parts of aggregate with sufficient water added to obtain a consistency as dry as may be practicable. The screed shall be rendered with a wood float and struck off with a steel trowel after set has commenced.

The granolithic mixture shall be floated onto the concrete floor slab within 12 hours of the latter having been laid. Where this cannot be done within 12 hours, the concrete surfaces shall be thoroughly hacked, cleaned, watered and treated with approved cement slurry or with an approved bonding agent, as may be directed before the granolithic screed is laid.

Where a tinted granolithic screed is specified, it shall be placed in two layers, a lower layer placed to within 6 mm of the finished level and an upper layer into which the pigment has been mixed. No dusting on of colouring material will be allowed.

The surface of all granolithic screeds shall be kept damp for a period of at least 7 days after laying by covering it with polyethylene sheeting or by thickly covering it with wet sand, sawdust or Hessian kept moist by frequently sprinkling it with water.

The granolithic screeds shall be not less than 20 mm thick, finished to falls as shown on the Drawings, and shall be laid in panels not exceeding 4,0 m in any direction.

Where shown on the Drawings or directed by the Employer's Agent thresholds shall be finished with granolithic screeds 25 mm thick, treads 25 mm thick, and risers 20 mm thick, including rounded nosings and reedings.

Edges next to walls shall be finished with projecting skirting, 75 mm high, with rounded top edges, unless otherwise specified or instructed by the Employer's Agent.

PSU 5.2 Installation of Doors And Windows

All built in door and window frames shall be set straight, plumb and level, and shall operate to the satisfaction of the Employer's Agent after fixing has been completed.

Fittings shall be either removed, or wrapped and protected from damage, until all rough trades have been completed.

PSU 5.3 Glazing

Glass shall be cut in panes to suit all glazed openings with sufficient clearance all round to prevent cracking by expansion, contraction or vibration.

In all cases the glass shall be well bedded and back puttied and installed as specified in SANS Code of Practice 0137.

All putty shall be carefully trimmed, cleaned off and neatly finished off straight with smooth surfaces and sharp mitres. A paint primer shall be applied as soon as the putty has dried out sufficiently to prevent shrinkage cracks from forming.

The entire glazing operation shall be cleaned before the premises are handed over for occupation.

PSU 5.4 Carpentry and Joinery

PSU 5.4.1 Carpentry work

a. Scope of work

Carpentry work shall be carried out in a manner consistent with good workmanship and in compliance with the Drawings.

The carpenter shall perform all cutting away and making good in attendance upon all other trades and he shall provide and maintain temporary coverings required for the protection of any finished work that might be damaged if left unprotected during the progress of the work.

b. Dimensions

"Unwrought" timber shall be "as sawn" and shall be to the dimensions and within the tolerances specified in the relevant SANS Standard Specifications mentioned in Sub Clause PSU 3.4 (a).

c. Jointing

Unless otherwise specified, all joints shall be secured by means of a suitable type and a sufficient number of approved connectors. All joints shall be carefully made in such a way that they will not impair the strength and stiffness of the beams or members.

d. Timber roof construction

The plates, joists, rafters, purlins, brandering and other pieces used for the construction of the roof and trusses shall be of the dimensions, spacing and construction, as shown on the Drawings.

All the joints in the framework shall be of the most appropriate type, accurately formed and adequately secured with fasteners as specified.

PSU 5.4.2 Joinery work

a. Scope of work

Joinery work shall consist of the manufacture, delivery to the Site, and fixing in the buildings, of all joinery shown on the Drawings.

Except where a special finish is specified, the Contractor shall have all stairs, landings, doors, shelves and other joinery work cleaned and scrubbed down and shall leave all his work in a good order to the satisfaction of the Employer's Agent.

b. Dimensions

All "wrought" timber shall be sawn, planed, drilled or otherwise machined or worked to the correct sizes and shapes shown on the Drawings.

Reasonable tolerance shall be provided at all connections between joinery works and the building structure to compensate adequately for any irregularities, settlements or any other movements.

c. Fabrication

The joiner shall perform all the necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all the other works necessary for correct jointing. He shall also provide all metal plates, screws, nails and other fixings that may be necessary for doing the specified joinery work properly.

d. Joints

Where joints are not specifically indicated, they shall be the recognised forms of joints for each position. The joints shall be so made as to comply with part 2 of BS 1186.

e. Doors and frames

Door frames, linings, panel doors, framed, ledged and braced doors, flush doors, sliding doors, etc. shall be supplied or made by the joiner and shall be installed, fitted or hung as detailed on the Drawings.

All timber shall be "wrought" and prepared for oiling, staining, varnishing or painting.

f. Skirting, cornices, etc.

Skirting, cornices, etc. shall not be installed until after the wall coverings have been applied, the flooring laid and ceilings installed, unless otherwise specified.

g. In situ joinery

In situ joinery work shall not be executed until after all floor, wall and ceiling surfaces have been formed or constructed, unless otherwise instructed.

h. Ceilings

Ceilings shall consist of fibre cement panels as shown on the Drawings and shall be nailed to the brandering or suspended from the roof structure. The

panels shall be separated by exposed tees and insulated with a 50 mm thick fibreglass wool blanket where shown on the Drawings.

PSU 5.5 Roof Covering and Accessories

a. General

Roofs shall be left perfect and watertight on completion of the work, and all gutters and valleys shall be cleaned out.

b. Metal Roof sheeting

Wherever possible, roof sheets shall be of a single length from eave to eave. However, if these lengths exceed the standard sheet lengths, the number of laps shall be kept to a minimum and shall conform to the manufacturer's recommendations for the roof slopes indicated. End laps extend beyond the purlin or rail by 150 mm.

Sheeting shall be fixed to purlins with approved screws, each complete with a galvanized steel washer over an approved sealing grommet.

The sides of sheets shall be lapped over for a minimum of one corrugation or according to the manufacturer's recommendations and shall be stitched with approved screws or blind rivets.

All laps in sheeting shall be sealed with an approved sealant. Swarf, grindings and surplus fasteners shall be removed from the roof on completion. Holes for fasteners shall be drilled and not punched.

Flashings, ridging, eaves closers, etc. shall be of the size and shape necessary to suit the sheeting used. Flashings shall be of an approved type and shall be properly cut, lapped, shaped, dressed and fixed in an approved manner to render a waterproof finish. Provision shall be made for expansion and contraction in long lengths and at expansion joints of the building.

Gutters shall be fixed on suitable brackets and shall fall to outlets, all as directed by the Employer's Agent. Gutters and brackets shall be standard units.

All down pipes shall be watertight and shall be fixed 25 mm clear of the finished wall face or structure by means of suitable brackets, and at approved spacings. The positions of the down pipes shall be as directed by the Employer's Agent.

c. Roof tiling (both clay and concrete)

Note: All roofs to be tiled shall be provided with an underlay regardless of the slope of the roof.

Roof tiling shall be laid according to the "broken bond" method, and vertical joints between tiles and the bottom edge of each course of tiles, shall range perfectly straight.

For roof slopes up to 25° tile overlap shall not be less than 100 mm and for steeper slopes not less than 75 mm.

Half tiles shall be provided as required at abutments and at verges of roofs.

Unless otherwise specified, each tile in every third course, all tiles in eaves courses and ridge courses, end tiles in every course at each side of hips and valleys, half tiles and full tiles at verges, and all tiles to open eaves and open overhanging verges shall be secured to the battens with galvanised wire having a diameter of 1,6 mm passed through the holes in nibs, and wound round the battens or round stout galvanised clout-headed nails driven into the battens.

Tiling shall be carefully cut and dressed at hips and valleys and, where necessary, at abutments, etc. Mitred portions of tiles at hips and valleys shall be holed and properly secured.

Hip and ridge tiles shall be of the same material and manufacture as the roofing tiles, with a minimum cover of 75 mm over the top course of tiling on each side and with collars for overlapping joints, and shall be bedded and pointed in 1 to 3 cement mortar, with strips of approved bituminous sheeting laid under the mortar bedding of such a width as will give a lap of at least 25 mm onto the tiling at each side and lapped not less than 75 mm at end joints.

All hip tiles and every fourth ridge tile shall be holed and fixed with approved nails.

The hip and ridge junction tiles, stop ends, etc. shall be of approved design, made to work in with ridging and ordinary tiles and bedded and pointed as before.

d. Roof underlays

Underlays shall be draped over the rafters in such a manner that both horizontal and vertical overlaps are at least 150 mm. The underlay shall further extend over the tiling fillet and fascia board and into the eaves gutter in such a manner that no troughs be formed behind the fascia board to inhibit the free drainage of any condensation that may be formed.

e. Setting out of tiled roofs

i. Positioning top and bottom battens

Fix the bottom batten which is to carry the eaves or first course of tiles so that it allows an overhang of the tiles over the fascia board and of one third of the gutter. Fix the top battens so that the gap between the tiles of the two ridge courses is not more than 100 mm.

ii. Batten gauge

The distance between the top of the eaves batten to the top of the top batten must be divided into equal batten gauges, which must not exceed those prescribed for the tile to be fixed (i.e. (for clay tiles) not exceeding 320 mm for roof slopes up to 25° and not exceeding 345 mm for steeper slopes).

Fixing battens

The nails for fixing battens and counter battens should be of sufficient length to penetrate the rafter by 40 mm. Ensure that all batten joints are located on a rafter.

iii. Setting out tiles

Set out a full course of tiles over the eaves course, starting with the correct overhang at the right hand verge. By opening or closing all the joints between the tiles it should be possible, given a normal run of eaves, to complete the required eaves length using only whole tiles and hence eliminating cutting.

Note: All general tile patterns are designed to allow a side lock tolerance of approximately 3 mm. Hence, by using this side lock tolerance along an eaves length; tile cutting can generally be avoided.

iv. Keeping perpendicular lines true

This can be achieved by striking perpendicular chalk lines from eaves to ridge at three tile intervals. If the tiles are subsequently laid so that their edges coincide with these lines, the roof tiles will be perpendicular and a raking left-hand verge will be avoided.

v. Keeping horizontal lines true

This can be achieved by marking the batten gauge on a rod to make corresponding marks on the underlay or rafter across the roof.

Note: The bargeboard should not be fitted and the battens should not be cut until the above setting out procedure has been completed.

PSU 5.5 Wall and Floor Tiling

a. Tiles shall be fixed to walls with an approved adhesive and finished with white cement joints. Tiles shall be laid with straight joints and arranged symmetrically in the tiling pattern.

b. Concrete tiles and all other types of hard tiles used as floor cover shall be bedded in cement mortar and shall be laid level. Tiles shall be laid with straight joints and flush with granolithic work, where applicable.

c. Vinyl floor tiles shall be laid level and with straight joints. the adhesive compound used and the method of laying employed shall be strictly in accordance with the tile manufacturer's instructions.

PSU 5.6 Paint

Refer to the Particular Specification G02: Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction (Golder Associates, 2006 Edition).

PSU 5.7 Waterproofing of Concrete Roofs

The water proofing material shall be properly bonded or stuck to the concrete slab and shall be sealed up against parapets and properly flashed, sealed and dressed down into outlets and flashed around all protrusions all as shown on the Drawings.

On completion the entire surface area of the waterproofing shall be given two coats of a reflective paint compatible with the waterproofing material and be left neat, clean and watertight.

The whole of the waterproofing installation must be carried out by specialists appointed by the manufacturer and the work must be guaranteed against any defects in material and/or workmanship for a period of ten years. Should any leaks become apparent during this time, the Contractor must undertake to have same repaired without delay and at his own cost.

PSU 6 TOLERANCES

Not applicable to this Section.

PSU 7 TESTING

Not applicable to this Section.

PSU 8 MEASUREMENT AND PAYMENT

PSU 8.1 Brickwork

a. 345 mm thick (state type of brick outside face and inside face)

Unit: Square metre (m²)

b. 230 mm thick (state type of brick outside face and inside face) **Unit: Square metre (m²)**

c. 115 mm thick (state type of brick) **Unit: Square metre (m²)**

The unit of measurement shall be the square metre of each type of brickwork built, calculated from the leading dimensions of the brickwork. Areas of windows, doors etc. built into brickwork shall not be included in the areas measured for payment. At corners and intersections common to more than one brick wall, the areas shall be measured only once.

The tendered rate shall include full compensation for the construction of the brickwork complete as specified, including pointing, the building in of conduits, beams, pipe sleeves, doors, windows, the raking out of joints, damp proof course, bricks on edge (if applicable) etc.

PSU 8.2 Roof Bearings on Brick walls

a. Masonite bearings as specified (state width) **Unit: Metre (m)**

b. Commercial bearing as specified (state type) **Unit: Metre (m)**

The tendered rate shall include full compensation for supply of material, cutting waste, applying grease where applicable and laying on top of brickwork including the mortar bed with steel trowel finish.

PSU 8.3 Plaster Work

a. Single coat or first coat (thickness indicated)

i. wood float finish **Unit: Square metre (m²)**

ii. steel float finish **Unit: Square metre (m²)**

b. Second coat (thickness indicated) **Unit: Square metre (m²)**

c. Finishing coat **Unit: Square metre (m²)**

The unit of measurement shall be the square metre of each type of coat completed as specified.

The tendered rate shall include full compensation for the construction of the plaster work, including the supply of all materials, mixing, applying, finishing, forming reveals, joints, etc. complete as specified.

PSU 8.4 Floor Screeds

a. Normal screeds (thickness and finish indicated)
Unit: Square metre (m²)

b. Granolithic screeds (thickness and finish indicated)
Unit: Square metre (m²)

c. Extra-over (a) or (b) for skirting (or nosing's or reeding)
Unit: Metre (m)

The unit of measurement shall be the square metre of floor screed laid, as specified, on floors, steps or areas shown on the Drawings or as designated by the Employer's Agent.

The tendered rate shall include full compensation for the construction of the floor screeds skirting, etc., including the supply of all materials, mixing, laying and finishing.

PSU 8.5 Tiling

a. Wall tiles (type and location) **Unit: Square metre (m²)**

b. Floor tiles (type and location) **Unit: Square metre (m²)**

c. Quarry tiles (type and location) **Unit: Square metre (m²)**

The unit of measurement shall be the square metre of each type of tile laid.

The tendered rate shall include full compensation for laying, jointing and pointing of tiles, including the supply of all materials necessary to complete the tiling, including any cutting and waste, all as specified.

PSU 8.6 Waterproofing of Concrete Roofs

The unit of measurement shall be:

a. Main surface **Unit: Square metre (m²)**

b. GMS or other approved flashing **Unit: Metre (m)**

The tendered rate for the main surface shall include full compensation for the supply of all material, including installation of waterproofing, welding of joints, gluing down, sealing and painting with protective paints all as specified.

The tendered rate for the flashing shall include full compensation for the supply and installation of the flashing including all fasteners and silicone sealant as specified.

PSU 8.7 Rainwater Outlets

Supply and installation of 100 mm diameter cast-iron full-bore rainwater outlet **Unit: Number (No)**

The unit of measurement shall be the number of outlets, installed.

b. Extra over item PSU 8.7(a) for the supply and installation of 80 mm diameter screwed and socketed galvanised steel pipes and fittings.

i. (medium quality screwed and socketed pipes **Unit: Metre (m)**

The unit of measurement shall be the linear metre of galvanised mild steel pipe installed

ii. etc. for fittings **Unit: Number (No)**

The unit of measurement shall be the number of fittings installed.

The tendered rates shall include full compensation for the supply of material, corrosion protection as specified, including building into brickwork, cutting and threading, waste and neatly sealing and finishing waterproofing around rainwater outlets.

PSU 8.8 Ironmongery

PSU 8.8.1 Doors and Windows

a. Steel door frames, including lintol (type and size indicated) **Unit: Number (No)**

b. Steel door with frame, including lintol (type and size indicated) **Unit: Number (No)**

c. Steel window frame, including burglar proofing, glazing, sills and lintols (type and size indicated) **Unit: Number (No)**

The unit of measurement shall be the number of steel door frames, steel doors with frames, dark bronze anodised aluminium doors with frames, steel windows with frames, dark bronze anodised aluminium windows with frames and adjustable louvers installed complete as specified. The tendered rate shall include full compensation for the installation of the doors, windows and louvers including the supply of all materials, manufacturing, installing, hinges, handles, locks, barrel bolts, retaining devices, door stops, stays and any other work necessary to complete the work as specified. The tendered rate for windows shall also include full compensation for glazing, windowsills, lintols and dampproof sheeting all as specified. For steel window frames the supply and installation of burglar proofing shall also be included in the tendered rate. For

aluminium windows the supply and installation a galvanized wire mesh (20 x 20 x 1.8 mm) screen, fixed to the inside of each adjustable louver in such a manner as not to prohibit the opening or closing of the louver as well as the supply and installation of hot dipped galvanized steel mullions between windows or where indicated on the drawing shall also be included in the tendered rate.

PSU 8.8.2 Fixed Louvers:

Supply and installation of approved powder coated steel louvers (state opening size) **Unit: Number (No)**

The unit of measurement shall be the number of louvers installed.

The tendered rate shall include full compensation for cutting of openings in walls and neatly finishing after the installation, including supply of necessary materials, wooden frames or 12 mm thick plastered sills and lintols (steel float), etc.

PSU 8.8.3 Security Gates

Supply and fixing of security gates.

a. Mild steel gates (size and type indicated) **Unit: Number (No)**

b. (Etc. for other sizes) **Unit: Number (No)**

The unit of measurement shall be the number of gates installed complete as shown on the drawing.

The tendered rate shall include full compensation for the installation of the gates, including the supply of all materials, manufacturing, installing hinges, handles, locks, barrel bolts, retaining devices and any work necessary to complete the work as shown on the drawing. The rate shall further include for

corrosion protection of the mild steel and applying a final coat of paint after erection. Colour to be approved by the Employer's Agent.

PSU 8.11 Joinery

a. Doors (type and size indicated) **Unit: Number (No)**

b. Other items measured by number **Unit: Number (No)**

c. Skirting (size indicated) **Unit: Metre (m)**

d. Other items measured by length **Unit: Metre (m)**

The units of measurement shall be the number or metre of each type and/or size of joinery item specified. The tendered rate shall include full compensation for the supply of all materials, manufacture, cutting, waste, fixing and installation of the joinery items.

PSU 8.14 Roof Ventilators

a. Roof Ventilators (Type and material indicated)

Unit: Number (No)

The unit of measurement shall be the number of roof ventilators installed as shown on the Drawings or directed by the Employer's Agent.

The tendered rate shall include full compensation for the installation of the ventilators, including the supply of all materials, manufacturing and sealing.

PSU 8.15 Paint Work

a. Steel door frames (type and size indicated) **Unit: Number (No)**

b. Steel door and frame (type and size indicated) **Unit: Number (No)**

c. Steel window frame including burglar proofing (type and size indicated) **Unit: Number (No)**

d. Other sheet metal work **Unit: Square metre (m²)**

e. Structural steelwork **Unit: Kilogram (kg) weight**

f. Plastered or concrete walls (interior) **Unit: Square metre (m²)**

g. Plastered or concrete walls (exterior) **Unit: Square metre (m²)**

h. Concrete soffit ceilings **Unit: Square metre (m²)**

The unit of measurement for paintwork will be as stated above.

The tendered rates shall include full compensation for the supply and application to the complete satisfaction of the Employer's Agent of all protective and decorative coatings required, as specified for the various structural members in the Particular Specification G02: Corrosion Protection.

SECTION VA: ANCILLARY WORK: LANDSCAPING AND GRASSING

PSVA 1 SCOPE

This section covers the landscaping and/or the establishing of vegetation in such areas as indicated on the Drawings or ordered by the Employer's Agent, in writing, including rehabilitation of borrow pits, stockpile and spoil areas and the contractor's work areas, access roads, office and store areas etc.

PSVA 2 INTERPRETATIONS

PSVA 2.1 Supporting Specifications

The following specifications shall, inter alia, form part of the Contract Document:

a. SANS 1200A

b. SANS 1200D.

PSVA 3 MATERIALS

PSVA 3.1 Fertilizer

The type of fertilizer to be used shall be as specified or ordered by the Employer's Agent or scheduled.

PSVA 3.2 Grass Cuttings

Grass cuttings shall be fresh and in a good condition for planting, with sufficient root material to ensure good growth. Species to be planted shall be as specified or scheduled.

PSVA 3.3 Grass Seed

Only good quality fresh seed shall be used. The types of seed in the mixture and the pure live seed content shall be as specified or scheduled.

PSVA 3.4 Trees, Shrubs and Ground Covers

Plants shall be of the variety and size shown on the Drawings.

When trees, shrubs and ground covers are supplied and delivered to the Site by the Employer, the Contractor shall give the Employer's Agent at least six weeks advance notice of his requirements. Upon receipt of the plants, the Contractor shall ensure that the plants are in good condition and free from obvious diseases and shall accept full responsibility to maintain the plants in good condition throughout the Contract. The plants shall be fully maintained

and watered during this period, and any losses of plants due to lack of maintenance or diseases developing during the Contract period shall be replaced at the Contractor's expense.

Plants shall be handled and packed in the approved manner for the particular species or variety, and all necessary precautions shall be taken to ensure that plants will arrive at the point of use in proper condition for successful growth. Trucks used for transporting plants shall be equipped with covers to protect plants from windburn. Containers shall be in a good condition.

Plants supplied by the Contractor shall be healthy, shapely and well rooted. Roots shall not show any evidence of having been restricted or deformed at any time. Plants shall be well grown and free from insect pests and diseases.

PSVA 3.5 Grass Sods

Grass sods shall be of approved quality and shall be harvested, delivered and planted within 36 hours, unless otherwise authorized by the Employer's Agent. Grass sods shall be free from noxious weeds and diseases and shall contain a minimum of 30 mm of soil.

Sods shall be of the variety of grass specified or scheduled. The grass shall have been grown specifically for sod purposes, mown regularly and maintained to provide an approved quality of uniformity. It shall be harvested by special machines manufactured for this purpose to ensure an even depth of cut with sufficient root material and soil.

PSVA 3.6 Anti Erosion Compounds

Anti erosion compounds shall consist of a plastic material in dispersion, such as Verdyol or a similar approved compound, which can be sprayed onto the soil to bind and protect it against erosion.

PSVA 3.7 Topsoil

Topsoil shall consist of fertile loamy soil selected from areas showing a good coverage of natural vegetation, preferably grasses. It shall be free from deleterious matter such as large roots, stones, refuse, stiff or heavy clays and noxious weeds, which would adversely affect its suitability for the planting of grass.

Topsoil shall be obtained wherever suitable material occurs; either from the Site or from borrow areas to be cleared, as described in Sub Clause 5.2.1.2 of SANS 1200D. The Employer's Agent shall indicate his requirements to the Contractor regarding the quantity of topsoil required and the areas at which it shall be selected and when it shall be removed. Unless otherwise specified or as instructed by the Employer's Agent, topsoil shall not be taken from more than 400 mm below the original undisturbed surface. If the Contractor fails to conserve topsoil as instructed, he shall obtain suitable substitute material from other sources at no extra cost to the Employer.

Where so specified, the Contractor shall procure and supply topsoil from his own sources outside the Site. Such sources shall be subject to the approval of the Employer's Agent.

Topsoil shall be stockpiled in separate loose heaps as tipped from the trucks and shall not be stockpiled higher than 2,0 m.

PSVA 3.8 Manure

Manure shall, unless another type is approved by the Employer's Agent, be pure "kraal" manure, free from soil, weed seed or other objectionable material. It shall not contain any particles that will not pass through a 50 mm screen. Only manure which has been approved by the Employer's Agent shall be delivered to the Site.

PSVA 3.9 Compost

Compost shall be well decayed, friable and free from weed seed, dust and other objectionable materials.

PSVA 4 Plant

Not applicable to this Section.

PSVA 5 CONSTRUCTION

PSVA 5.1 Landscaping of Areas

PSVA 5.1.1 Shaping

Areas that require shaping which involves bulk earthworks, such as contoured areas, shall be excavated, filled, compacted when required, and shaped to the correct contours to within a tolerance of plus or minus 150 mm. Such work shall be considered as earthworks and measurement and payment shall be made under SANS 1200D, except that quantities may be measured by means of a grid of levels taken at 10 m intervals before and after shaping, or by means of levelled cross sections.

PSVA 5.1.2 Trimming

Trimming shall consist of bringing the existing or previously shaped ground to an even surface with the final levels generally following the original surface. Trimming shall normally be done by grader, or, in more confined or steep areas, by bulldozer. Where machine operations are not practicable because of confined spaces or steep slopes, trimming shall be done using hand tools.

All trimming alongside roads and streets shall be completed before landscaping commences. Such trimming shall be carried out on both sides of the road or street up to the boundaries of the road reserve unless otherwise specified or instructed by the Employer's Agent.

Where applicable, trimmed surfaces shall be left slightly rough to facilitate binding with topsoil or the natural establishing of vegetation.

When subsequent grassing is required or when instructed by the Employer's Agent, areas previously shaped shall be trimmed as described above to within a tolerance of plus or minus 25 mm, with all undulations following a smooth

curve. The above tolerance shall apply only to areas where the final contours are given in the Drawings.

During trimming, all stones in excess of 50 mm in size and all excess material shall be removed. The trimming of any areas requiring grass shall be done in such a way that, after cultivation and application of any topsoil, the finished surface of the area shall be approximately 25 mm below the top of adjacent kerbing, channelling or pavement.

PSVA 5.1.3 Plant rates

The Employer's Agent shall be entitled to pay for shaping and trimming as described above on the basis of the hourly rates for motor graders and bulldozers. The motor grader and bulldozer to be provided shall each have a fly wheel power of not less than 93 kW. Any labour or other plant ordered shall be paid for as "extra work" as specified in Clause 5.7 of the GCC (2015).

PSVA 5.2 Preparation of Areas For Grassing

The various areas to be grassed shall be prepared as follows:

PSVA 5.2.1 Areas Not Requiring Topsoil

Where the areas to be grassed consist of organically suitable material, they shall be scarified to a minimum depth of 150 mm. All loose stones larger than 30 mm on areas to be mowed by machine shall be removed.

PSVA 5.2.2 Areas Requiring Topsoil

Where areas to be grassed consist of organically unsuitable material, the surface shall be roughened to ensure a proper bonding between the topsoil and the subsoil. If required, the area shall be scarified as described in Sub Clause PSVA 5.2.1 above.

Topsoil shall be placed on the prepared surfaces and trimmed to the uniform thickness required. The topsoil shall be prepared by means of hand rakes or

light rotavators to obtain a smooth surface. All stones shall be removed as specified for areas not requiring topsoil in Sub Clause PSVA 5.2.1 above.

PSVA 5.2.3 Fertilizing

The Contractor shall have the top 150 mm of the prepared surfaces tested to determine the amount and type of fertilizer required for establishing proper growing conditions for the grass. The fertilizer shall be evenly applied over all surfaces where grass is to be planted and shall then be thoroughly mixed with the soil, either mechanically or manually, to a depth of 150 mm. Where hydroseeding is to be performed, the fertilizer may be mixed with the cellulose pulp and water used in hydroseeding.

PSVA 5.3 Grassing

The method of establishing grass shall depend on the circumstances relating to each case. The method to be used in each case shall be agreed on by the Employer's Agent and the Contractor.

PSVA 5.3.1 Planting Of Grass Cuttings

The areas to be planted shall, unless they are wet, be thoroughly watered before planting to ensure that the soil will be uniformly wet over a depth of at least 150 mm during planting.

The Contractor shall plant an approved variety of grass cuttings, using his own method, in such a way as to obtain a sufficient number of live and actively growing plants per square metre to provide an acceptable cover as defined in Sub Clause PSVA 5.4.2 of this section. At least 70 grain bags of cuttings shall be planted per hectare. Only fresh cuttings shall be used. Grass cuttings that have been allowed to dry out shall not be used. Immediately after planting the grass cuttings shall be given a copious watering and when sufficiently dry shall be rolled with a light agricultural roller.

PSVA 5.3.2 Sodding

Areas to be grassed by sodding shall be given a layer of topsoil at least 75 mm thick unless the Employer's Agent instructs that the topsoil be omitted where suitable subsoil is present. The areas to be sodded shall be thoroughly watered beforehand so that they will be wet to a depth of at least 150 mm after sodding. The surface shall be slightly roughened to ensure a good penetration of roots into the soil. Sods shall be protected against drying out and shall be kept moist from the time of harvesting until finally placed.

Wherever possible, the first row of sods shall be laid in a straight line and, if on a slope, laying shall be started at the bottom of the slope. The sods shall be butted tightly against each other and care shall be taken not to stretch or overlap the sods. Where a good fit cannot be obtained, the intervening space shall be filled with topsoil. The next row shall similarly be placed tightly against the bottom row with the joints staggered, and so on, until the entire area is covered with sods. On the instructions of the Employer's Agent, sods shall be held in position on steep slopes by a sufficient number of robust wooden stokes approximately 300 mm in length by 20 mm in diameter.

Each section of completed sodding shall be lightly rolled and thoroughly watered.

PSVA 5.3.3 Hydroseeding

The types and mixtures of seeds to be used shall be as specified or scheduled if not so specified and shall be agreed on by the Employer's Agent and the Contractor before any seed is ordered for use by the Contractor. The Contractor shall be solely responsible for establishing an acceptable grass cover, and any approval by the Employer's Agent of seed or seed mixtures proposed for use shall not relieve him of this responsibility.

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

Hydroseeding shall then be carried out with the use of an approved hydroseeding machine at a rate of application of not less than 38 kg of seed mixture per hectare, unless otherwise specified in the Project Specifications.

When the use of an anti-erosion compound is required and the compound is to be applied simultaneously with the hydroseeding, it shall be mixed with the hydroseeding mixture before application. In this case the amount of cellulose pulp shall be decreased by one third to a half, depending on the amount of compound added.

PSVA 5.3.4 Grassing of Borrow Pits, Temporary Bypasses, Camp Sites, Access Roads And Stockpile Sites

Prior to any grassing that may be required on borrow areas, the finishing off of borrow pits as described in Sub Clause 5.2.2.2 of SANS 1200D, the obliteration of bypasses and access roads as described in clause 5.8 of SANS 1200A and the clearing of camp sites as described in SANS 1200A shall have been carried out as specified in the relevant sections.

PSVA 5.4 Establishing and Maintenance of Grass

PSVA 5.4.1 Watering, Weeding, Cutting and Replanting

All sodded and planted areas shall be adequately watered at frequent and regular intervals in order to ensure proper seed germination and the growth of grass until the grass has established to an acceptable cover and thereafter until the beginning of the maintenance period of the grass. The amount and frequency of watering shall be subject to the Employer's Agent's approval. Where hydroseeding is carried out, the commencement of watering may be postponed until a favourable time of the year, but watering shall in any case commence and continue as soon as the seeds have germinated and growth begins.

The Contractor shall mow the grass on all areas that have been grassed, whenever so instructed by the Employer's Agent, until the end of the contract period.

All grass cuttings shall be collected and disposed of if so directed by the Employer's Agent. Weeds shall be controlled by means of pulling or cutting or by any other approved means. Any bare patches where the grass has not

taken, or where it has been damaged or has dried out shall be re-cultivated, planted, sodded or hydroseeded at the Contractor's expense.

PSVA 5.4.2 Acceptable cover

An acceptable grass cover shall mean that not less than 75% of the area planted or hydroseeded shall be covered with grass and that there shall be no bare patches the maximum dimension of which shall not exceed 500 mm. In the case of sodding, acceptable cover shall mean that the full area shall be covered with live grass at the end of any period of not less than three months after sodding.

PSVA 5.5 Trees, Shrubs and Ground Covers

PSVA 5.5.1 Positions of Plants

The positions in which trees, shrubs and ground covers are to be planted shall be as indicated on the Drawings or as determined by the Employer's Agent, and care shall be taken that the taller plants will not obscure traffic signs.

PSVA 5.5.2 Preparation of Plant Holes

Unless otherwise directed by the Employer's Agent, holes for trees and shrubs shall be placed and prepared as follows:

a. All holes shall be square in plan.

b. For shrubs the holes shall be at least 500 mm square by 600 mm deep.

c. For trees the holes shall be at least 600 mm square by 700 mm deep.

d. The planting holes shall be refilled with selected and approved topsoil, thoroughly mixed with manure or compost (one heaped spade full added to every plant hole) and, depending on soil test reports, the required amount and type of fertilizer.

e. The holes shall be thoroughly watered before planting. Where the local soil has poor drainage, 150 mm of broken rock shall be placed at the bottom of the planting hole before filling it with soil.

PSVA 5.5.3 Planting

Before planting, the plants shall be well watered before they are removed from their containers.

Ground cover plants shall be carefully lifted from their containers and transferred to holes in the prepared soil, which holes shall be just large enough to accommodate the plant and the adhering soil. Care shall be taken to avoid exposure of the roots during planting. Soil for ground covers shall be prepared as for grassing as specified in clause PSVA 5.2.

Directly after the planting, plants shall be well watered to establish them firmly in the soil. After the soil has set, additional soil shall, in the case of trees and shrubs, be added where necessary to bring the backfill material to within 150 mm of the ground surface to ensure the retention of sufficient water. All trees shall be tied to a suitable creosote treated timber stoke planted firmly in the ground. The stoke shall have a minimum diameter of 35 mm and shall be at least 300 mm longer than the planted tree, with a maximum length of 3 m above the ground. After planting the ground surface around the plants shall be covered with straw or grass or any other type of mulch to minimize evaporation.

PSVA 5.6 General

PSVA 5.6.1 Time of planting

The planting of grass, trees, shrubs and ground covers shall be carried out as far as is practicable during periods most likely to produce beneficial results. The Contractor shall make every effort to programme his operations to make this possible.

PSVA 5.6.2 Traffic on Grassed Areas

The Contractor shall not plant grass until all operations that may require construction equipment to be taken over the grassed areas have been completed. No equipment, trucks or water carts shall be allowed on areas that have been grassed and only equipment required for the preparation of areas, the application of fertilizer and the spreading of topsoil will be allowed to operate on areas ready for grassing.

PSVA 5.6.3 Erosion control

During construction, the Contractor shall protect all areas susceptible to erosion by installing all necessary temporary and permanent drainage works as soon as possible and by taking such other measures as may be necessary to prevent the concentration of surface water and the scouring of slopes, banks and other areas.

Runnels or erosion channels developing during the construction period or during the maintenance period shall be backfilled and consolidated and the affected areas shall be restored to their former proper condition. The Contractor shall not allow large scale erosion to develop before effecting repairs and all erosion damage shall be repaired as soon as possible and, in any case, not later than three months before the end of the maintenance period. Topsoil washed away shall be replaced.

PSVA 5.6.4 Proprietary Brand Materials Used for Erosion Control

Proprietary brands of materials that may be required for erosion protection to enable natural grass to become established shall be to the approval of the Employer's Agent.

PSVA 5.6.5 Responsibility for Establishing An Acceptable Cover

Notwithstanding the fact that the method of grassing and the type of seed or grass used and the rate of seed application may be specified or agreed to by the Employer's Agent, and that the frequency of mowing will be as instructed by him, the Contractor shall be solely responsible for establishing an acceptable grass cover and for the cost of replanting or re-hydroseeding where

an acceptable cover has not been obtained. Where, however, in the opinion of the Contractor, it is doubtful from the outset whether an acceptable cover can be established, he may inform the Employer's Agent of his reasons for this, and the Employer's Agent shall, if he agrees, either adopt another grassing method or agree to accept whatever cover can be obtained, provided that all reasonable efforts are made to establish a good cover by the method proposed. Such agreement shall only be valid if given in writing by the Employer's Agent.

PSVA 5.7 Site-Specific Rehabilitation Requirements

PSVA 5.7.1 Rehabilitation of Construction Activity Sites (Such As Batch Plants, Offices, Workshops, Access Roads, Borrow Areas, Etc.)

The rehabilitation measures include:

Soil and vegetation must be rehabilitated before the last rainy season.

The following remedial action must be applied to compacted soil according to the construction areas in which they occurred:

Soils that were compacted by construction vehicles must be ripped to a depth not less than 0,5-m with a D7 or similar type tracked equipment.

Where soils were not compacted by construction vehicles the subsoil must be ripped to 150mm with a grader of similar equipment.

All soil originally stripped from the areas must be placed and spread uniformly to create a free draining area.

All oil contaminated or otherwise polluted soil and wastes from the vehicle park/site office areas must be removed to licensed landfill sites using a registered waste disposal company and a certificate obtained.

All damaged fences and gates must be repaired before rehabilitation is completed.

All roads impacted by construction must be repaired and reinstated to their original condition.

PSVA 5.7.2 Reseeding of Disturbed Areas

The primary purpose for reseeding is to facilitate the re-establishment of natural vegetation and thereby limit soil erosion. Since alien invasive species are prone to establish more quickly in disturbed areas, reseeding must be undertaken in tandem with an alien invasive plant control programme. The measures required for reseeding are given below:

All areas that were affected by construction activities must be reseeded;

All reseeding activities must be undertaken at the end of the dry season (middle to end September) to ensure optimal conditions for germination and rapid vegetation establishment.

Disturbed areas must be nipped to refusal or a minimum of 500mm a mix of 2:3:2 N:P:K fertilizer at 1ton/ha must be used to soil amelioration. Disturbed areas must be harrowed after spreading 100mm topsoil uniformly.

The area must be seeded with a mix of 3 kg/ha Eragrostis curvula, 6kg/ha Cynodon dactylon, 6 kg/ha Digitaria eriantha, 1kg/ha Eragrostis tef and 6 kg/ha Chloris gayana.

An agricultural roller must be used to cover seeds.

Rehabilitated areas must be inspected at three monthly intervals during the first and second growing season to determine the efficacy of rehabilitation measures.

Appropriate remedial action must be taken where vegetation establishment has not been successful or erosion is evident.

Weeds, especially Khakibos Tagetes minuta, Blackjack Bidens pilosa must be controlled with a broadleaf herbicide that is non-toxic to the environment and is used sparingly.

No construction equipment, vehicles or unauthorized personnel will be allowed onto areas that have been re-vegetated; and

Only persons/ equipment required for maintenance thereof will be allowed to operate on such areas.

PSVA 6 TOLERANCES

Not applicable to this Section.

PSVA 7 TESTING

Not applicable to this Section.

PSVA 8 MEASUREMENT AND PAYMENT

PSVA 8.1 Trimming

a. Machine trimming **Unit: Square metre (m²)**

b. Hand trimming **Unit: Square metre (m²)**

NOTE: All bulk earth moving operations as described in Sub Clause PSVA 5.1.1 shall be measured and paid for under SANS 1200D.

The unit of measurement for trimming shall be the square metre of area trimmed on the Employer's Agent's instructions, including areas trimmed after shaping.

The tendered rate shall include full compensation for trimming areas to the specified finish, including the moving of small quantities of material which would be inherent in this process, and the removal of surplus material and stones. For payment purposes a distinction shall be made between machine trimming that can reasonably be carried out by bulldozer or motor grader, and hand trimming that cannot be done by machine owing to confined space, steep slopes or difficult shapes.

PSVA 8.2 Use of Machines For Trimming Or Shaping (Alternative To Sub Item PSVA 8.1(A))

a. Bulldozer **Unit: Hour (h)**

b. Motor grader **Unit: Hour (h)**

The unit of measurement shall be the hour actually worked by each machine in trimming or shaping areas. Standing time shall not be measured.

The tendered rates shall include full compensation for the supply and use of the machines, including the cost of fuel, operators, maintenance, transporting the machine to and from the point of use, and for all other incidentals necessary to carry out the work.

PSVA 8.3 Preparing Areas for Grassing And Ground Covers

a. Scarifying **Unit: Hectare (ha) or square metre (m²)**

b. Topsoiling on the Site with:

i. Topsoil obtained from the Site or borrow areas provided by the Employer (state thickness) **Unit: Square metre (m²)**

ii. Topsoil obtained by the Contractor from other sources (including all haulage) (state thickness) **Unit: Square metre (m²)**

c. Topsoiling of borrow pits with topsoil obtained from borrow areas or from the Site (state thickness) **Unit: Square metre (m²)**

d. Supplying and applying chemical fertilizers:

i. Lime **Unit: Ton (t)**

ii. Super phosphate **Unit: Ton (t)**

iii. Limestone ammonium nitrate **Unit: Ton (t) or kilo gram (kg)**

iv. (iv) 2:3:2 (22) **Unit: Ton (t)**

v. (v) Other fertilizers if required (type stated) **Unit: Ton (t)**

e. Stockpiling of topsoil **Unit: Cubic metre (m^3)**

The unit of measurement for scarifying shall be the hectare or square metres of ground scarified and prepared as specified. Only areas scarified on the written instructions of the Employer's Agent shall be measured for payment.

The tendered rate shall include full compensation for scarifying, removing stones and smoothing the surface.

The unit of measurement for topsoiling shall be the square metre of topsoil applied to the specified thickness or as directed by the Employer's Agent, measured in situ after the topsoil has been placed. The quantity shall be calculated from the net area of the surface topsoil, before the application of grass sods. Any topsoil placed in excess of the average thickness specified or ordered shall not be measured for payment.

For payment purposes a distinction shall be made between topsoil obtained from designated areas on the Site or borrow areas and topsoil obtained by the Contractor from outside sources found by him when sufficient topsoil is not available from the said designated areas. For payment purposes a further

distinction shall be made between topsoil applied to areas on the Site and topsoil applied to borrow areas.

The tendered rate shall include full compensation for constructing the topsoil as specified, including any royalties or compensation that may be payable in the case of topsoil under Sub item PSVA 8 (b) (ii).

The unit of measurement of fertilizer shall be the ton or kilogram of each type of fertilizer ordered and applied.

The tendered rate shall include full compensation for supplying the fertilizers, and for fertilizing the designated surfaces, all as specified.

The unit of measurement for stockpiling of topsoil shall be the cubic metre of topsoil stockpiled on the written instructions of the Employer's Agent, where this operation is unavoidable despite proper advance planning. Only material actually loaded, transported to and stockpiled on sites designated for stockpiling shall be measured, and not any material merely pushed or bladed into heaps adjacent to the area from which it was taken.

The tendered rate shall include full compensation for removal and loading the topsoil, transporting it, placing it in stockpile, and for any payments to private owners for the use of stockpile areas.

PSVA 8.4 Grassing

a. Planting of grass (type indicated) **Unit: Square metre (m^2)**

b. Sodding (type indicated) **Unit: Square metre (m^2)**

c. Revegetation cylinders (description) **Unit: Metre (m)**

d. Hydroseeding:

i. Providing approved seed mixture for hydroseeding (type indicated) **Unit: Kilogram (kg)**

ii. Hydroseeding (type indicated) **Unit: Hectare (ha)**

The unit of measurement for the planting of grass cuttings shall be the square metre of established grass with an acceptable grass cover.

The tendered rate shall include full compensation for the planting of grass cuttings, the establishing of an acceptable cover, the replanting of dead areas and the maintenance of the grass, all as specified, but excluding the mowing of grass.

The unit of measurement for sodding shall be the square metre covered with sods and having an acceptable cover.

The tendered rate shall include full compensation for sodding, the establishing of an acceptable cover, the replanting of dead areas, and the maintenance of the grass, all as specified, but excluding the mowing of the grass.

The unit of measurement for revegetation cylinders shall be the metre of revegetation cylinders furnished and placed as specified, measured along the rows in which they are placed end to end.

The tendered rates shall include full compensation for constructing and maintaining the revegetation cylinders, all as specified. Topsoiling shall be paid for separately under items PSVA 8.3 (b) and (c) and due allowance shall be made for excluding the volume occupied by the revegetation cylinders from the volume of topsoil measured for payment. Hydroseeding shall be paid for separately.

The unit of measurement for hydroseeding shall be the hectare of grass established by hydroseeding and having an acceptable cover. The unit of

measurement for providing seed shall be the kilogram of seed of the specified mixture, excluding the mass of any pulp added thereto.

The tendered rate shall include full compensation for planting grass by hydroseeding the establishing of an acceptable cover, re-hydroseeding bare patches, and the maintenance of the grass, all as specified, but excluding the mowing of the grass.

General

Half the payments under item PSVA 8.4 shall become due when the grassing or hydroseeding has been carried out, and the remainder shall become due when a satisfactory cover has been established, except in the case of Sub item PSVA 8.4(c) where the full amount will become due upon the satisfactory execution of the work.

PSVA 8.5 Mowing of Grass Unit: Hectare (ha)

The unit of measurement shall be the hectare measured each time when the grass has been cut on the instructions of the Employer's Agent.

The tendered rate shall include full compensation for all plant, equipment and labour required for each grass cutting and the disposal of grass cuttings, i.e., payment shall be made every time the grass has been cut on the instructions of the Employer's Agent.

PSVA 8.6 Approved Anti Erosion Compound

Anti-erosion compound (type indicated) **Unit: Kilogram (kg)**

The unit of measurement shall be the kilogram net mass of anti-erosion compound used as approved by the Employer's Agent.

The tendered rate shall include full compensation for supplying the material and mixing and applying it with the hydroseeding or by itself.

PSVA 8.7 Management of Weeds Unit:Square Meters (m^2)

The unit of measurement shall be the square meter and shall be paid the Contractor on the instructions of the Employer's Agent.

The tendered rate shall include full compensation for all plant, equipment and labour required as well as for the disposal of the weeds.

PSVA 8.8 Extra Work For Landscaping Unit: Provisional sum

The provisional sum allowed shall be expended at the discretion of the Employer's Agent to cover the cost of work in addition to the scheduled items that may be required in respect of landscaping when plant is used at hourly rates, e.g. the cost of loading and transporting surplus material, in respect of establishing the grass by topsoiling only, repairing erosion damage after topsoil has been applied, or in respect of any other items of work required for which no pay items have been provided.

Payments shall be made as specified in Clause 6.6 of the GCC (2015).

PSVA 8.9 Site-Specific Rehabilitation

The cost of rehabilitation of the areas affected by the Contractor's activities on the site will be for the Contractor's account and must be provided for in the Bill of Quantities.

The requirements for rehabilitation are covered in PSVA 5.6.1 and PSVA 5.6.2.

SECTION VB: ANCILLARY WORK: FENCING

PSVB 1 SCOPE

This section covers the erection of new fences, the moving of existing fences, the erection and later removal of temporary fences and the dismantling of existing fences.

PSVB 1.1 Types of Fences

The following types of fences shall be erected in accordance with the dimensions shown on the Drawings:

a. High density (high tensile) anti-climbing and anti-cut pressed mesh panel transparent fencing including shark tooth spike topping.

PSVB 2 INTERPRETATIONS

The following Specifications shall, inter alia, form part of the Contract Document:

a. SANS 1200 A

b. SANS 1200 C

c. SANS 1200 G

d. The Particular Specification G02: Corrosion Protection.

PSVB 3 MATERIALS

PSVB 3.1 Gates

Gates shall comply with the requirements of CKS 146 and shall be manufactured to the dimensions shown on the Drawings.

Gates shall be complete in every respect, and shall include hinges, bolts, nuts, washers and locking mechanisms as shown on the drawings.

PSVB 3.2 Materials for Temporary Fences

All new material for temporary fences shall be of the same quality as the material for new fences. Second hand material, whether available on Site or purchased, shall be submitted to the Employer's Agent for approval before use.

The protective galvanized coating on all second hand fencing wires shall be intact but may have a rusty appearance provided that the rust is superficial and does not impair the structural strength of the items.

PSVB 3.3 Materials for High-density (high tensile) anti-climbing & anti-cut pressed mesh panel fencing

High density anti-climbing and anti-cut pressed mesh panel fencing 2,4m high, formed of 3mm diameter horizontal and 3mm diameter vertical high tensile wires. Fence to be powder coated charcoal with aperture size 76,2mm x 12,7mm and reinforcing V-section ribs, bolted with vandal resistant bolts and clamping plates to 85 - 45mm Taper locking post 3,0m high including Locking Recess mechanism at 3,382m centres with sealed end caps and 30 x 3mm x 250mm long angle section base anchors. Posts to be bedded in 15MPa concrete bases size 400 x 400 x 600mm deep.

Anti-burrow Mesh Extension 600mm deep fixed to the underside of fencing including excavations and bedding.

100mm high galvanised “shark tooth” type spike rails, bolted to 50mm wide mesh flange bent along flange top.

PSVB 3.7 Concrete

Concrete used for fencing shall comply with the requirements of SANS 1200G.

PSVB 4 Plant

Not applicable to this Section.

PSVB 5 CONSTRUCTION

PSVB 5.1 Clearing of Fence Line

Strip clearing for the fence shall be carried out and paid for in accordance with SANS 1200C.

PSVB 5.2 Installing High Density Anti-Climbing and Anti-Cut Pressed Mesh Panel Fencing

Unless otherwise shown on the Drawings, High density anti-climbing and anti-cut pressed mesh panel fencing 2,4m high, formed of 3mm diameter horizontal and 3mm diameter vertical high tensile wires. Fence to be powder coated

charcoal with aperture size 76,2mm x 12,7mm and reinforcing V-section ribs, bolted with vandal resistant bolts and clamping plates to 85 - 45mm Taper locking post 3,0m high including Locking Recess mechanism at 3,382m centres with sealed end caps and 30 x 3mm x 250mm long angle section base anchors. Posts to be bedded in 15MPa concrete bases size 400 x 400 x 600mm deep.

Anti-burrow Mesh Extension 600mm deep fixed to the underside of fencing including excavations and bedding.

100mm high galvanised “shark tooth” type spike rails, bolted to 50mm wide mesh flange bent along flange top.

PSVB 5.3 Installing Gates

Gates shall be installed at the positions indicated on the Drawings. The gates shall be hung on gate fittings in accordance with the details shown on the Drawings. Gates shall be so erected that they swing in a horizontal plane at right angles to the gate posts and clear of the ground in all positions. Double swing gates shall close to have gaps as shown on the Drawings.

PSVB 6 TOLERANCES

The completed fences shall be plumb, taut, true to line and to the ground contour, and with all posts, standards and stays firmly set.

The height of the lower fencing wire above the ground at posts and standards shall not vary by more than 25 mm from that shown on the Drawings. Other fencing wires shall not vary by more than 10 mm from their prescribed relative vertical positions.

Anchoring of a fence to structures shall be done as shown on the Drawings.

The Contractor shall, on completion of each section of fence, remove all cut offs and other loose wire or mesh so as to leave the fence with a neat and finished appearance.

Any cracked or damaged section of the palisade fencing shall be removed and replaced.

PSVB 7 TESTING

Not applicable to this Section.

PSVB 8 MEASUREMENT AND PAYMENT

PSVB 8.1 Supply and Installation of High Density (High Tensile) Anti-Climbing And Anti-Cut Pressed Transparent Mesh Panel Fencing

High Density (High Tensile) Anti-Climbing and Anti-Cut Pressed Mesh Panel Fencing complete including anti-burrow mesh an 100mm high galvanised "shark tooth" type spike rails.
Unit: Metre (m)

The tendered rates shall include full compensation for all excavations, concrete, formwork and the completed fence as indicated on the drawings.

PSVB 8.2 New Gate

a. Motorised galvanised steel mesh gate **Unit: Number (No)**

The unit of measurement shall be the number of new gates erected. A pair of gates shall be measured as one.

The tendered rate shall include full compensation for barrel bolts, tubular receivers, catches, chains, padlocks etc. and for the erection of the gates as specified and as shown on the Drawings.

PSX INSTRUMENTATION WORK

INTRODUCTION

This part contains the specific requirements for the project regarding instrumentation work that is to be carried out for the Storage Reservoir and associated piping and valve System at the new Carlswald Reservoir site.

The scope of work consists of:

- Level sensors
- Flow meters
- Actuators,
- Telemetry system
- Alarm and surveillance system
- SCADA connection

ULTRASONIC LEVEL SENSORS

Supply and install two ultrasonic level meters, LIT001 and LIT002 in the two opposite sides of the Reservoir, complete with brackets, supports, instrument junction boxes, terminals, surge protection, etc. Connect these ultrasonic level meters to the new Reservoir Telemetry system. The junction boxes will contain the transmitters, terminals, circuit breakers for local isolation, surge protection, etc. The junction boxes must comply with all the requirements of the attached “Automation and Control Standards, Volume 19, Field Junction Boxes” and the level meters must comply with all the requirements of the attached “Automation and Control Standards, Volume 9, Level Measurement”.

The Level Sensor JB details below must be read in conjunction with drawings 13214-73-06-010 and 13214-73-06-004,

Type: Outdoor powder coated 304 steel frame mounted with lockable front door.

Supply: 2.5mm² x 3 core PVC SWA PVC cable plus 10mm² bare copper earth plus 0.5mm² x 4pr twisted PVC SWA PVC (individually and overall screened)

Colour: Electric orange

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehn guard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
All	Front panel mounted LED display for instantaneous Level in percentage	Display
All	Pulsar type ultrasonic level controller complete with ultrasonic level transmitter mounted inside the reservoir	Level Transmitter
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitz ductor XT from DEHN guard..	Signal & Data Surge Protection

ELECTROMAGNETIC FLOW METERS

Assist Mechanical contractor with supply and install two electromagnetic flow meters, FIT001 (Inlet flow meter) And FIT002 (outlet flow meter), supply and install supports, instrument junction boxes, terminals, surge protection, etc. Connect FIT001 and FIT002 to the new Reservoir telemetry system. The junction boxes will contain the transmitters, terminals, circuit breakers for local isolation, surge protection, etc. The junction boxes must comply with all the requirements of the attached

"Automation and Control Standards, Volume 19, Field Junction Boxes" and the flow meters must comply with all the requirements of the attached "Automation and Control Standards, Volume 8, Flow Measurement".

The flowmeter details below must be read in conjunction with drawings 13214-73-06-010 and 13214-73-06-005.

Type: Outdoor powder coated 304 steel frame mounted with lockable front door and transparent window for meter reading purposes. Transparent window must be covered with top hinged powder coated 304 cover for ultra violet protection of controller.

Supply: 2.5mm² x 3 core PVC SWA PVC cable plus 10mm² bare copper earth plus 1.5mm² x 3core plus 0.5mm² x 4pr twisted PVC SWA PVC (individually and overall screened)

Colour: Electric orange

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehn guard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
All	Front panel mounted LCD display for instantaneous flow and totalized flow counter.	Display
All	Mag-Flow Controller supplied by mechanical contractor. Free issue item which must be installed in enclosure: Plus	Mag-flow
All	Pipe connections to pipeline and coordination with mechanical contractor: Plus	Mechanical Contractor coordination
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring

QTY	DESCRIPTION	IDENTIFICATION
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitz ductor XT from DEHN guard..	Signal & Data Surge Protection

ELECTRICAL ACTUATORS

Assist Mechanical contractor with supply and install two Actuator, AV001 And AV002, supply and install supports, instrument junction boxes, terminals, surge protection, etc. Connect AV001 and AV002 to the new Reservoir telemetry system. The junction boxes will contain the transmitters, terminals, circuit breakers for local isolation, surge protection, etc. The junction boxes must comply with all the requirements of the attached “Automation and Control Standards, Volume 19, Field Junction Boxes” and the flow meters must comply with all the requirements of the attached “Automation and Control Standards, Volume 8, Flow Measurement”.

The flowmeter details below must be read in conjunction with drawings 13214-73-06-010, 13214-73-06-006 and 13214-73-06-007.

Type: Outdoor powder coated 304 steel frame mounted with lockable front door with indicator lights, push buttons and selector switch.

Supply: 1.5mm² x 7core PVC SWA PVC cable plus 10mm² bare copper earth plus 2x 0.5mm² x 4pr twisted PVC SWA PVC (individually and overall screened)

Colour: Electric orange

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main

QTY	DESCRIPTION	IDENTIFICATION
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehnguard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
All	Front panel mounted Open/ Close push buttons.	Manual open close
All	LED type indicator Lights for open and Closed indication	Open Close indication
All	4-20mA source with front panel mount multiturn potentiometer for manual positioning in manual mode	Manual position setting
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitzductor XT from DEHNguard..	Signal & Data Surge Protection

Telemetry System

The Johannesburg Waters specifications dictates that the telemetry system consists of the following separate distribution boards mounted against a wall in close proximity of each other.

- Inverter and battery DB
- Marshing Panel
- Radio Battery DB
- Telemetry I/O cards and Radio DB (Outstation)

The DB's boxes must comply with all the requirements of the attached "Automation and Control Standards, Volume 19, Field Junction Boxes" and the flow meters must comply with all the requirements of the attached "Automation and Control Standards, Volume 8, Flow Measurement".

Telemetry I/O and Radio DB (Outstation)

The outstation details below must be read in conjunction with the following JW requirements.

All analogs except battery voltage must be galvanic isolated at the RTU side and must have lightning protection at the instrument side if outside the building. All Outstations must have the following analogs (Minimum requirement)

i. Battery Voltage
iv. Inflow / Outflow (Clamp on Ultrasonic if not a check meter . Including Bunker close to meter to reduce special cable)
v. Ultrasonic level transducer (Current Type= Pulsar)
vi. Submersible level transducer (Current Type = ITS
vii. 20 % spare analogs and termination capacity

All digitals except door switches , must have lightning protection at the signal side if outside the building. All outstations must have the following Digitals (Minimum requirement)

i. Main Door Alarm
ii. Telemetry Door Alarm
iii. Mains Fail
iv. Flow Counters
v. Passive Infra-Red Detector
ix. 20 % spare Digital and termination capacity

Type: Outdoor powder coated 304 steel frame mounted with lockable front door.
Supply: 1.5mm² x 4core PVC SWA PVC cable plus 10mm² bare copper earth plus 12 x 0.2mm² twisted PVC SWA PVC (individually and overall screened)
Colour: Painted Light Beige– C57 (SANS 1091:2012) external, White arc-free internal
Fault level: 2.5kA
Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehnguard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
1	Radio GE Orbit UHF compatible with 1x Serial and 2x Ethernet port compatible with SD4 radios.	Radio
1	PSU – COMPATABLE WITH SSE PROTOCOL Power Supply with lightning protection	PSU
All	COMPATABLE WITH SSE PROTOCOL Outstation ribbon type , standard (RTU-Maistro), I/O Modules , galvanic isolators , LPU's , ¼ Wave LPU, Internal wiring , Wiring to J/Box , Installation and commissioning	RTU
1	Door open switch	Door open
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitzductor XT from DEHNguard..	Signal & Data Surge Protection

Marching Panel

Type: Outdoor powder coated 304 steel frame mounted with lockable front door

Supply: 1.5mm² x 7core PVC SWA PVC cable plus 10mm² bare copper earth plus 12x 0.2mm² twisted PVC SWA PVC (individually and overall screened)

Colour: Painted Light Beige– C57 (SANS 1091:2012) external, White arc-free internal

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehnguard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitzductor XT from DEHNguard..	Signal & Data Surge Protection

Radio battery DB

Type: Outdoor powder coated 304 steel frame mounted with lockable front door.

Supply: 1.5mm² x 7core PVC SWA PVC cable plus 10mm² bare copper earth plus 2x 0.5mm^2 x 4pr twisted PVC SWA PVC (individually and overall screened)

Colour: Painted Light Beige– C57 (SANS 1091:2012) external, White arc-free internal

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
All	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehnguard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Surge arrestor
1	48Ah 12V deep cycle battery	12 V Battery
1	Door open switch	Door open

QTY	DESCRIPTION	IDENTIFICATION
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring

Battery & Inverter DB

The flowmeter details below must be read in conjunction with drawings 13214-73-06-010, 13214-73-06-006 and 13214-73-06-007.

Type: Outdoor powder coated 304 steel frame mounted with lockable front door with indicator lights, push buttons and selector switch.

Supply: 1.5mm² x 7core PVC SWA PVC cable plus 10mm² bare copper earth plus 2x 0.5mm² x 4pr twisted PVC SWA PVC (individually and overall screened)

Colour: Painted Light Beige– C57 (SANS 1091:2012) external, White arc-free internal

Fault level: 2.5kA

Equipment will be the following:

QTY	DESCRIPTION	IDENTIFICATION
1	2Amp Continues Rated SP MCB: (10A can be used) Plus	Main
1	Single Phase class 2 surge arrestor unit connection type 2 as per SANS 10142-1 equal or similar to Dehnguard. DVMTT255 with remote indicator panel & remote signaling contacts connected to the SCADA: Plus	Invertor
All	Fuses.	Protection
1	24V intelligent battery charger (PB-600-24)	Battery charger
4	200AH 12V sealed Lead Acid batteries connected 2 sets of (2x12v in series, i.e 24V) in parallel (400Ah @ 24V)	Batteries
All	Terminals and interconnecting monitoring and control wiring: Plus	Connection and monitoring

QTY	DESCRIPTION	IDENTIFICATION
	Signal & Data Surge protection unit suitable for the application equal or similar to Blitzductor XT from DEHNguard..	Signal & Data Surge Protection

PLC And SCADA Software

The PLC and SCADA programming will be done by others. No cost needs to be allowed for this, but the contractor must allow costs to provide the Engineer with commissioning assistance.

Certification of IS Designs

The tenderer must allow a cost for the certification of the Engineer's intrinsically safe circuit designs by a suitable authority such as Ark Holdings, Explolabs, etc. Similarly, a cost must be allowed for the testing and certification of the installation after completion.

Training of C&I Personnel

The tenderer must allow an amount to cover the cost of training of up to two Johannesburg Water personnel by the supplier (not only the contractor) on new instrumentation supplied on this contract. Training will be by the supplier at the supplier's premises or on site. If no training is required, then this amount will not be claimed.

C&I Maintenance Spares

The tenderer will be required to provide a recommended list of instrumentation spares, including PLC equipment and data communications equipment including, but not limited to, at least one type of each PLC I/O module processor and power supply, spare Ethernet Switch etc., for at least the following three years maintenance. The tenderer must allow a corresponding cost for these spares in the BOQ.

PSY: ELECTRICAL WORK

INTRODUCTION

This part contains the specific requirements for the project regarding electrical work that is to be carried out for the Storage Reservoir and associated piping and valve System at the new Carlswald Reservoir site.

The scope of work consists of:

- Power supply to the Reservoir site main LV distribution board DB-01
- Sub DB's, DB-02 and DB-03
- Electrical reticulation on site,
- Site lighting
- Aviation lights according to SA-CATS 139 Standard
- Small power and lighting in buildings
- Earthing and lighting protection on site
- Alarm and surveillance system fro site and buildings
- Electric fence

CABLES RACKS

The Vendor will be responsible for the Design supply and installation of all the cable, cable racking. The cable Racks will be fixed as per design and specifications below.

The Vendor shall install cable racking for all MV and LV cables. Cable racks must be bonded together between every break in their length using a 6 mm^2 ICEW and at both cable ladder ends using a 35 mm^2 ICEW.

The cable rack installation must comply with all the requirements of the attached "Particular Specification E02, Electrical Cable Racks" and "Particular Specification E11, General Electrical Earthing and Lighting Protection".

ELECTRIC FENCE

The electric fence shall be installed on the boundary around the new reservoir site and operated so that they cause no electrical hazard to

persons, animals or their surroundings. The energizer shall be of 2-zone battery operated (12V 7AH nominal) suitable for connection to mains 230V 50Hz nominal and shall be located in the new security hut. The batteries to be used shall preferably be rechargeable LiFeOP4 batteries. Non-rechargeable batteries must NOT be used. Electric fence constructions which are likely to lead to the entanglement of animals or persons shall be avoided. The electric fences shall be of 2-zone, and each of the two zones to have the same energizer. The electric fence shall be of 8- strand, on 1200mm x 20mm x 20mm square tube pole. The bobbin shall be of the pop-em insulator type and the wire shall run through (inside) the bobbin.

The electric fence shall be identified at frequent intervals by prominently placed warning signs securely fastened to the fence post or firmly clamped to the fence wires. The size of the warning signs shall be at least 100mm x 200mm as indicated on the image below:



Warning signs shall be placed at:

- Each gate
- Each access point
- Intervals not exceeding 10m
- Adjacent to each sign relating to chemical hazards for the information of emergency services

Gates in electric security fence shall be capable of being opened without the person receiving an electric shock.

The energizer earth electrode shall penetrate the ground to a depth of at least 1m. The distance between any electric fence earth electrode and other earth systems shall not be less than 2m.

Connecting leads that are run inside the buildings shall be effectively insulated from the earth structural parts of the building. This may be achieved by using insulated high voltage cable.

Connecting leads that are run underground shall be run in a conduit of insulating material or else high voltage cable shall be used. Care shall be taken to avoid damage to the connecting leads due to external factors.

Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables. Mains supply wiring shall not be installed in the same conduit as signaling leads associated with the electric fence installation.

The electric fence and their ancillary equipment shall be installed, operated and maintained in a manner that minimizes danger to persons, and reduces the risk of persons receiving an electric shock unless they attempt to penetrate the physical barrier or are in a secure area without authority.

Exposed conductive parts of the physical barrier shall be effectively earthed.

Protection from the weather shall be provided from the ancillary equipment.

SITE LIGHTING HIGH MASTS

Site lighting will be done via 2 x 15 m masts each equipped with 3 x LED Flood lights and LED flood lights mounted on the outside of the valve building, telemetry hut and the reservoir rim. See drawing 13214-73-06-013 for more details.

15m High Masts

Two (x2) 15m high scissor mast are required and shall be positioned as indicated on drawing 13214-73-06-013, each mast shall be equipped with three (x6) warm white LED type G floodlights with lamps on top of each mast, see below.

Type G	:	208W warm white LED Floodlight. The luminaire consists of an LED engine, power supply and spigot compartment. It shall be secured by stainless steel latches and an access screw. The LED engine, consisting of the LED light source and the power supply, shall be easily replaceable. Both compartments are rated IP66. Electronic temperature monitoring prevents overheating of LEDs and power supply, positioned directly next to LEDs. The luminaire housing shall be manufactured of marine grade aluminum. Equal or similar to LED Flood from Beka.

Flood light

The Flood lights shall be positioned as indicated on drawing 13214-73-06-013. The flood lights required will be as per the legend of above mentioned drawing.

Aviation Light

Four (x4) ICAO/FAA approved aviation obstruction warning LED type lights shall be positioned as indicated on drawing 13214-73-06-013. This light shall be connected to a photocell and UPS power supply.

Intermediate lights shall consist of at least 3 single units spaced at 120-degree intervals, depending on the diameter of the structure, and may below intensity type “A” lights of at least 10 candelas. When flashing lights are used, the flashes shall be synchronised.

FIELD STOP/START STATIONS (ISOLATOR STATIONS)

Supply and install field mounted Stop/Start stations for all the rotating machinery.

All mounting accessories and support structures MUST be included in the tender price.

The Stop/Start stations shall be installed within a 1000 mm radius of the accompanying motor.

Each of the isolators must be equipped complete with supports, racking, mounting brackets and enclosures.

The Stop/Start stations and isolators must comply with the relevant requirements of the attached specification “Electrical Design Standards, Volume E03, Electrical Isolator Pushbutton Stations”.

EARTHING AND LIGHTNING PROTECTION

The Vendor shall appoint a reputable company to design, install test and commission the earthing and lightning protection in and around the new Reservoir, new valve building, telemetry hut, guard hut and electric fence, etc.

The Vendor shall submit a full set of drawings detailing the design intent and installation methods to be used by the earthing and lighting protection company for review and approval by the Electrical Engineer. The installation shall ONLY commence once the drawings are approved by the Engineer.

All new metal parts, structures and equipment are to be bonded to the general plant earth system.

The Earthing and Lightning Protection must comply with the relevant requirements of the attached specification “Particular Specification, Volume E11 : Electrical Earthing and Lighting Protection” as well as SANS 10313, and take into account the details of drawing 13214-73-06-012 and 13214-73-06-002

LV CABLES

The Vendor will be responsible for the supply and installation of all the LV cable, including the termination of all LV cables. The cables will be fixed to a cable rack, passed through conduit or buried in a trench. See detail on drawings 13214-73-06-001 and 13214-73-06-013

LV cables will be installed between the new MCC's and all the downstream equipment.

The cables (and the installation thereof) must comply with the attached specifications: "Particular Specification, E02, Electrical Cable Racks, "Particular Specification, E05, Electrical Low Voltage Power and Control Cables, "Particular Specification, E06, Electrical Medium and Low Voltage Installation and "Particular Specification, E09, Electrical Building Installation".

The following cables should be allowed for under this contract.

DESCRIPTION	NO.	FROM	TO	Route Length
16mm² 4C PVC SWA PVC CU Cable	1	Point of Supply	DB-01	75
16mm² Bare Copper Earth Wire	1	Point of Supply	DB-01	75
16mm² 3C PVC SWA PVC CU Cable	1	DB-01	DB-02	100
16mm² Bare Copper Earth Wire	1	DB-01	DB-02	100
16mm² 3C PVC SWA PVC CU Cable	1	DB-01	WP1	45
16mm² Bare Copper Earth Wire	1	DB-01	WP1	45
16mm² 3C PVC SWA PVC CU Cable	1	DB-01	DB-03	45
16mm² Bare Copper Earth Wire	1	DB-01	DB-03	45
2.5mm² 3C PVC SWA PVC CU Cable	2	DB-01	Inlet Flow meter Koisk	30
2.5mm² 3C PVC SWA PVC CU Cable	2	DB-01	Outlet Flow meter Koisk	30

2.5mm² 3C PVC SWA PVC CU Cable	2	DB-02	Level sensor kiosks	200
2.5mm² 3C PVC SWA PVC CU Cable	1	DB-02	24V Cabinet	10
2.5mm² 3C PVC SWA PVC CU Cable	2	DB-02	Telemetry Out station	10
16mm² 3C PVC SWA PVC CU Cable	1	DB-03	Aviation lights	180
16mm² 3C PVC SWA PVC CU Cable	1	DB-03	Exterior light Mast 1	80
16mm² 3C PVC SWA PVC CU Cable	1	DB-03	Exterior light Mats 2	150
70mm² Bare Copper Earth Wire	1	Reservoir	Earthing system	300
16mm² 3C PVC SWA PVC CU Cable	1	DB-03	Gate lights	55

CABLE TRENCHING

The Vendor shall allow for the excavation of trenches and road crossings in and around the Return Water Pump Station building and the site reticulation paths.

All trenching for the Control & Instrumentation and Electrical installation will be done under the Electrical scope of work.

There will be several road crossings along the cables routes.

The cabling and trenching shall comply with all the requirements of the attached “Particular Specification E05, Cabling” and “Particular Specification E06, Electrical Medium and Low Voltage Cable Installation”.

SMALL POWER AND LIGHTING

Note: All equipment must be approved by the Engineer or the representative prior to the installation of or any order being placed. The Vendor shall install small power and lighting in and around the new Valve building, telemetry hut, guard house and general site lighting.

A 'Gogga vanger' with an ultraviolet florescent tube light must be installed outside the entrance of the following buildings to control the bugs and insects. A photocell day/night switch will switch this.

- 1 x Valve building

The following small power and lighting DB's will be required for the project,

- Valve Building
- Guard House
- Telemetry Hut

The installation must comply with the attached specifications: "Particular Specification E05, Electrical Low Voltage Power and Control Cables", "Particular Specification E06, Electrical Medium and Low Voltage Cable Installation", "Particular Specification E07, Electrical Industrial Welding Plugs, Couplers and Socket Outlets", "Particular Specification E08, Electrical Wiring" and "Particular Specification, E09, Electrical Building Installation"..

Valve Building DB (DB-01)

Fault level:	5 kA fault level
Type:	Indoor flush wall mounted with front access and door.
Supply:	16 mm² x 4 core PVC SWA PVC cable plus 10 mm² bare copper earth from Electrical connection from Supply authority
Colour:	Painted Light Orange – B26 (SANS 1091:2012) external, White arc-free internal (see Painting and Finishing).

Refer to drawing no;
13124-73-06-003: Single line diagram,
13124-73-06-014: Valve Building Power and Lighting Layoutingle line diagram

Telemetry Hut DB (DB-02)

Fault level:	2.5 kA fault level
Type:	Indoor flush wall mounted with front access and door.
Supply:	16 mm² x 4 core PVC SWA PVC cable plus 10 mm² bare copper earth from Electrical connection from Supply authority
Colour:	Painted Light Orange – B26 (SANS 1091:2012) external, White arc-free internal (see Painting and Finishing).

Refer to drawing no;
13124-73-06-003: Single line diagram,
13124-73-06-009: Telemetry Hut Power and Lighting Layout line diagram

Guard house DB (DB-03)

Fault level:	2.5 kA fault level
Type:	Indoor flush wall mounted with front access and door.
Supply:	16 mm² x 4 core PVC SWA PVC cable plus 10 mm² bare copper earth from Electrical connection from Supply authority
Colour:	Painted Light Orange – B26 (SANS 1091:2012) external, White arc-free internal (see Painting and Finishing).

Refer to drawing no;
13124-73-06-003: Single line diagram,
13124-73-06-008: Guard house Power and Lighting Layout line diagram

DOCUMENTATION AND COMMISSIONING

The issuing of a Certificate of Compliance for each individual area/equipment in the entire installation must be included in the tender price.

QA documentation for each set of equipment must be provided.

Commissioning and setting up of all protection equipment must be included in the tender price AND overall commissioning assistance.

The vendors recommended list of commissioning spares must be included in the tender price.

Johannesburg Water SOC Ltd

CONSTRUCTION OF 20ML CARLSWALD RESERVOIR

VOLUME 2

PART 4: SITE INFORMATION

Employer:		**Contractor:**	
Witness:		**Witness:**	

TABLE OF CONTENTS

C4: Site Information S.1

1. General S.1
2. Site Location S.1
3. Access To Site And Restrictions S.1
4. Exisitng Services, Servitudes And Wayleaves S.2
5. Security S.2
6. Geotechnical Investigation S.2

C4: SITE INFORMATION

1. GENERAL

This section describes the site at the time of tender to enable the Contractor to price their tender, decide upon their method of working, as well as their programming and risks.

2. SITE LOCATION

The site is situated along Walton Road, in the suburb of Carlswald, Midrand, Johannesburg. The co-ordinates of the site are 25°58'50.13''S and 28°05'21.53''E.



3. ACCESS TO SITE AND RESTRICTIONS

Although the works are located on a site that lies within the Employer's property and/or reserve, the Contractor may need to request permission from the JRA to excavate road surfaces in order to execute the works required as part of this Contract. Any other required permissions shall be the responsibility of the Contractor to obtain.

Having been granted access to works area by the Employer, as well as other service authorities and private owners, the Contractor shall adhere to any agreed conditions of access. The Contractor must ensure that the works area is restored to a condition similar to what it was before the commencement of the works.

Employer:		**Contractor:**	
Witness:		**Witness:**	

4. EXISITNG SERVICES, SERVITUDES AND WAYLEAVES

Existing services along the site have not been identified through any subsurface detection mechanism. The Contractor will be responsible to identify all existing services along the site before commencing with the works. The Contractor will also be responsible for the procurement of any required servitude and wayleave approvals.

5. SECURITY

The Contractor shall be responsible for the security of his personnel, materials, equipment and construction plant on and around the site of the Works. He shall also be responsible for the security of his camp (if applicable). The Employer in this regard will consider no claims.

Refer to clause PS7.2 (Security).

6. GEOTECHNICAL INVESTIGATION

The existing ground and soil conditions are presented in the Geotechnical Report which was undertaken for the site (see attached).

It shall be the Contractor's responsibility to ensure that he acquaints himself with all necessary documentation in order to accurately compile his bid.

7. TOPOGRAPHICAL SURVEY

A detailed topographical survey was prepared for the site and is in the possession of the Employer's Agent. This information can be requested if required, as it shall be the Contractor's responsibility to ensure that he acquaints himself with all necessary documentation in order to accurately compile his bid.

Crossman, Pape & Associates

Consulting Geotechnical Engineers & Engineering Geologists

P.O.Box 3557 Cramerview 2060. Tel: (011) 465-1699. Fax: (011) 465-4586. Cell 082 556 7302 & 076 966 8445

REPORT NO 15/119/D **AUGUST 2015**

GEOTECHNICAL INVESTIGATION FOR PROPOSED 10 MEGA LITRE WATER RESEVOIR CARLSWALD

1. INTRODUCTION AND NATURE OF DEVELOPMENT

At the request of Mrs. J Heera of Zitholele Consulting we have carried out a geotechnical investigation for the proposed Carlswald 10ML Resevoir Project, Midrand. Confirmation of our appointment to proceed with the investigation was received via a sub-consultant agreement from Zithole Consulting. Copies of the site locality plan as well as three site layout options were received to facilitate the investigation.

The proposed reservoir will comprise either a 50m diameter by 5,5m high circular concrete structure or two 35m diameter by 5,5m high circular concrete reservoirs. The exact layout and positioning of the reservoirs is still to be finalized. Exact earthworks details are unknown at this stage.

2. TERMS OF REFERENCE

The terms of reference for the investigation are as follows:

i) to establish the nature and relevant engineering properties of the upper soil and rock strata underlying the site.

ii) to comment on suitable excavation procedures for cut terrace excavations and for the installation of services.

iii) to present comments on the use of the on-site soils in the construction of bulk fill terraces and as layerworks for access roads / parking areas.

iv) to give foundation recommendations for the proposed reservoir(s).

v) to comment on any other geotechnical aspects that may affect the development.

3. SITE DESCRIPTION

The area of investigation occurs across the eastern portions of the area of open land to the east of the intersection of Whisken Avenue and Walton Road,

Carlswald. The site slopes moderately to the south and is covered by veld grass and large trees across the eastern portions of the site.

4. NATURE OF INVESTIGATION

4.1 Fieldwork

Six test pits (TP15 to TP20) were excavated across the site on 13 July 2015 using a Cat 422E tractor-loader-backhoe (backactor). The test pits were excavated to refusal or to the excavation limit of the machine. All test pits were profiled in situ by an engineering geologist and where necessary disturbed soil samples were obtained for laboratory testing. The positions of the test pits are shown on the site plan enclosed in Appendix A. Copies of the recorded test pit soil profiles are presented in Appendix B.

4.2 Laboratory Testing

The following laboratory tests are currently being carried out on the soil samples recovered from the test pits during the field investigation.

(i) Atterberg limits and particle size distribution analyses to determine basic engineering properties and to effect classification.

(ii) Moisture/density and California Bearing Ratio (CBR) tests to evaluate compaction and related strength characteristics.

(iii) Soil chemistry tests to determine the pH and electrical conductivity of the in situ soils.

The report will be suitably amended and resubmitted once the laboratory test results become available.

5. SITE GEOLOGY/SOIL PROFILE

Available geological maps indicate that the area of investigation is underlain by **granite** of the Johannesburg Granite Dome. This was confirmed during the current investigation. Residual soils have developed from the weathering of the granite bedrock. The general soil profile is described below.

The upper soil layer across the site comprises 0,3m to 0,4m of loose to medium dense intact silty sand of **transported hillwash** origin. The hillwash is underlain by loose to medium dense / medium dense intact silty sand with abundant quartz gravel. This gravel layer represents the **transported pebble marker**. The pebble marker extends to depths varying between 0,55m and 0,7m.

The pebble marker is underlain by medium dense and dense in places cemented and ferruginised silty sand **reworked residual granite.** The reworked residual granite extends to depths varying between 1,0m and 1,3m. Refusal of the backactor was obtained upon very dense reworked residual granite at 1,3m depth in test pit TP16. The reworked residual granite is underlain by medium dense to dense jointed silty sand **residual granite.** Refusal of the machine was obtained upon dense residual granite / very soft rock granite at depths varying between 1,0m and 2,3m (average depth 1,7m). The excavation limit of the backactor was obtained at 3,0m depth within the residual granite in test pit TP18.

No perched water table or zones of seepage were noted in any of the test pits excavated across the site.

6. EXCAVATION PROCEDURES

Excavation procedures for earthworks and for the installation of services have been evaluated according to the South African National Standards standardized classifications for excavations (SANS 1200D, DA & DB). According to this classification the area of investigation classifies as **soft excavation** to depths varying between 1,0m and 2,3m (average depth 1,7m).

Below these depths the site classifies as **intermediate excavation** material on very dense reworked / residual granite and/or very soft rock granite. The intermediate excavation material is envisaged to be of the order of 0,5m to 1,0m thick and could be removed using medium to heavy earthmoving equipment and / or power tools.

Hard rock excavation on granite bedrock is envisaged below the intermediate excavation material. The hard rock excavation material would require excavation by **blasting.**

An exception to the above was noted in the vicinity of test pit TP18 where the soft excavation material extends to depths in excess of 3,0m.

7. MATERIALS USAGE

Laboratory testing is currently being carried out on the upper soil layers to assess their suitability for use in the construction of bulk fill terraces and as layerworks for access roads / parking areas. However, based on a visual assessment from the fieldwork the following comments are considered pertinent to the on-site soils with regards to the above operations.

- The upper 150mm of in situ soils across the site contains abundant organic matter and is unsuitable for use as construction material. This material should be removed to spoil. It is envisaged that in the vicinity of the large trees,that

at least the upper 0,5m of in situ soil would have to be spoiled owing to the presence of abundant tree roots. This depth would have to be verified upon commencement of the site cleaning.

- The in situ soils (hillwash, pebble marker and reworked / residual granite) are suitable for use as general fill and selected layer material. Should these soils be required for use as subbase then they would have to be stabilised. Further laboratory testing would however have to be carried out to establish suitable stabilising agents and to optimize mix ratios.

8. EVALUATION OF FOUNDING CONDITIONS AND FOUNDATION RECOMMENDATIONS

8.1 Areas of Cut

The hillwash and pebble marker soils are considered to be potentially highly compressible / collapsible. These soil layers are thus unsuitable for use as founding layers, even for proposed lightly loaded structures.

An allowable bearing pressure of 200kPa could be utilized for the medium dense or better reworked / residual granite. These founding layers occur at depths varying between 0,55m and 0,7m below current ground level. Under the above load conditions total settlements of the order of 5mm to 10mm are envisaged. Differential settlements should be taken as 50% of the total settlements. Conventional strip / spread foundations could be employed for the proposed reservoir structure(s).

8.2 Areas of Fill

Consideration could be given to placing strip / spread foundations within engineered fill with the following provisos:

- The fill must be compacted in 150mm layers to 95% of Mod AASHTO density at optimum moisture content.

- Allowable bearing pressures must be limited to 150kPa.

- All hillwash and pebble marker soils would have to be removed in their entirety to stockpile below the footprint of the reservoir within areas of the fill and to 1,0m beyond the edge of the reservoir footprint. Levels must then be reinstated within this removed hillwash / pebble marker in 150mm layers to 95% of Mod AASHTO density at optimum moisture content. This would have to be undertaken to prevent the sphere of influence of the foundation load extending down into the underlying collapsible hillwash / compressible pebble marker.

- It is important that a **high degree of engineering quality control** is implemented on the site with regard to the recompaction of the hillwash and the overlying bulk fill. **Density testing** using a suitable calibrated nuclear gauge device (Troxler) should be carried out on all compacted layers. The natural moisture content of the soils should be determined by oven drying in a soils laboratory, that is, the Troxler device should not be used to determine the natural moisture content of the engineered fill material. It is recommended that the density testing be carried out by an **independent soils laboratory.**

9. ACCESS ROADS AND PARKING AREAS

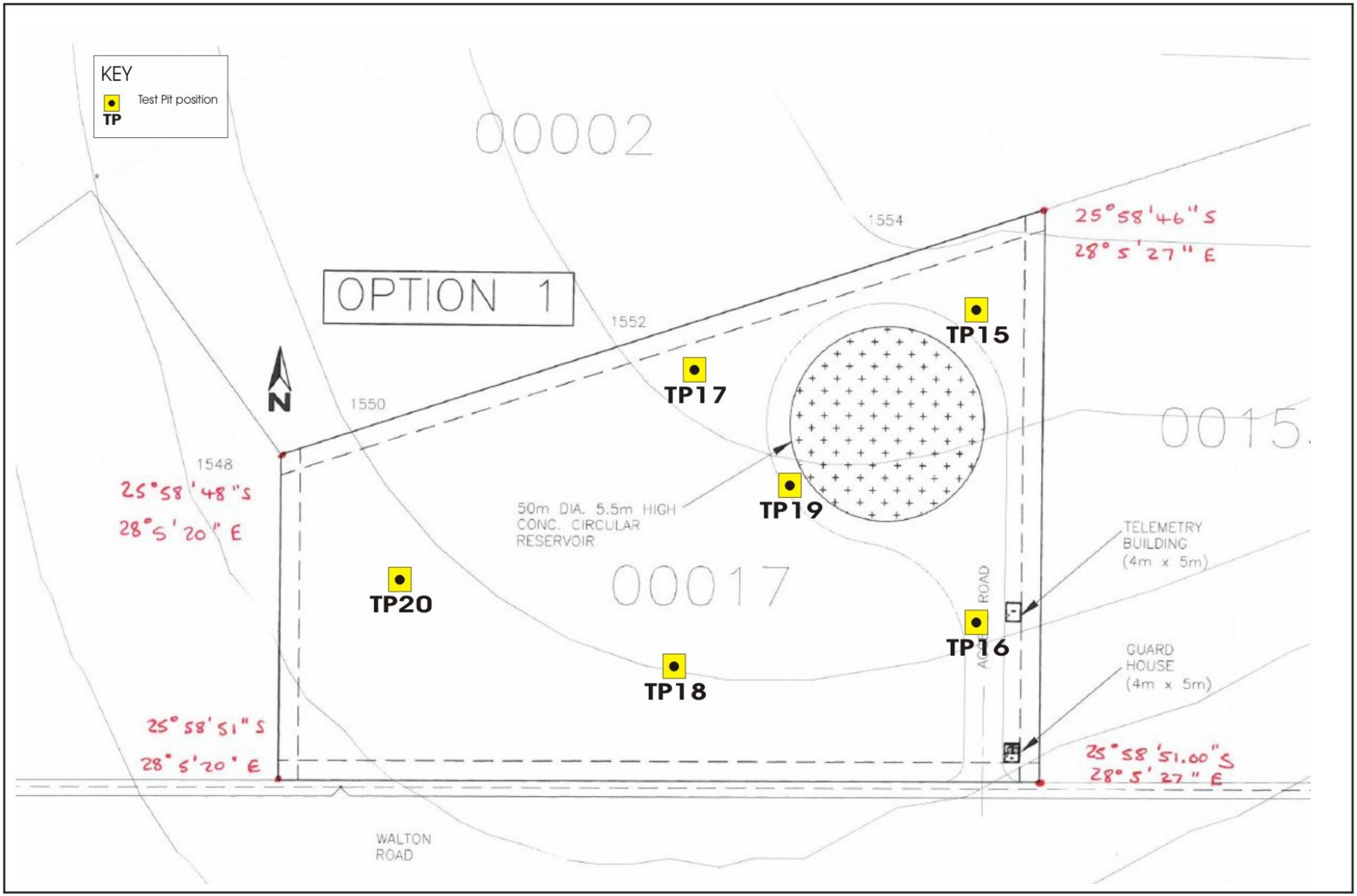
The following comments are pertinent to the design and construction of the access roads and parking areas.

- For pavement design purposes, it is estimated that the upper in situ subgrade material would have a CBR of the order of 10 percent if compacted to 90% of Mod AASHTO density at optimum moisture content, and of the order of 15 percent if compacted to 93% of Mod AASHTO density at optimum moisture content.

- If access roads and parking areas comprise brick paving it is recommended that the layer immediately below the brick paving and bedding sand be stabilised. The purpose of the stabilised layer immediately below the bedding sand would be to seal the layerworks from stormwater ingress from ground surface.



M CROSSMAN Pr Eng **J DAVEL Pr.Sci.Nat**
CROSSMAN, PAPE & ASSOCIATES



PROJECT: 15/119/D
OML RESERVOIR CARSLWALD

SITE PLAN INDICATING
APPROXIMATE POSITIONS OF TEST PITS

Crossman, Pape & Associates
Consulting Geotechnical Engineers & Engineering Geologists
PO Box 3557 Cramerview 2060, Tel: (011) 465- 1699, Fax (011) 465- 4586, Cell 082 556 7302 & 076 966 8445

Scale: Not to scale

Date: AUGUST 2015

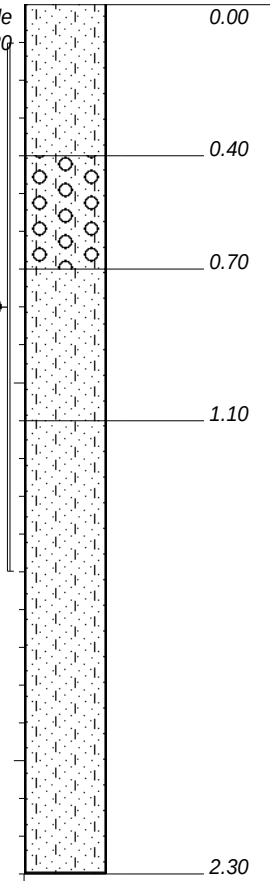
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP15
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist mottled and blotched red orange brown medium dense cemented and ferruginised silty sand. Reworked residual granite.
1.10	Moist orange brown speckled yellow dark brown medium dense to dense jointed silty sand. Residual granite.
2.30	

NOTES

1) Refusal at 2,3m on very dense residual granite / very soft rock granite.

2) No evidence of water.

3) Disturbed sample taken at 0,1--1,5m.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP15

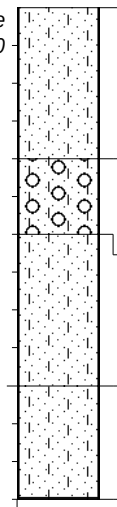
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP16
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abudant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.60	Moist orange brown mottled red brown grey medium dense cemented and ferruginised silty sand. Reworked residual granite.
1.00	As above but dense.
1.30	

NOTES

1) Refusal at 1,3m on very dense reworked residual granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel
TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015
DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP16

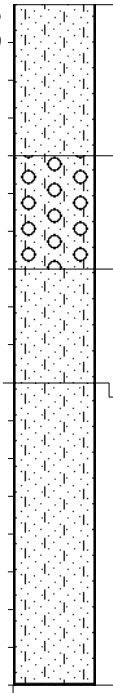
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP17
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist dark brown loose to medium dense intact silty sand. Hillwash. Also contains abudant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist orange brown mottled grey brown medium dense cemented and ferruginised silty sand. Reworked residual granite with zones of residual granite.
1.00	Moist orange brown speckled yellow dark brown medium dense to dense jointed silty sand. Residual granite.
1.80	

NOTES

1) Refusal at 1,8m on very dense residual granite / very soft rock granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP17

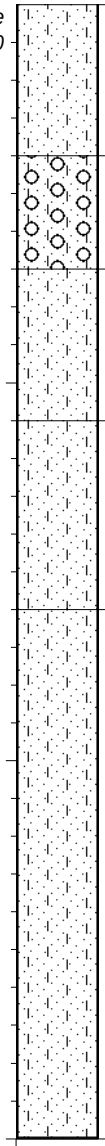
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP18
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but medium dense with abundant fine to coarse quartz gravel. Pebble marker.
0.70	Moist orange brown blotched grey brown mottled red brown medium dense and medium dense to dense in places cemented and ferruginised silty sand. Reworked residual granite with zones of residual granite.
1.10	Moist orange brown mottled grey red brown medium dense to dense jointed silty sand. Residual granite with zones of reworked residual granite.
1.60	As above but medium dense and medium dense to dense in places with no zones reworked residual granite.
3.00	

NOTES

1) No refusal at 3,0m.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

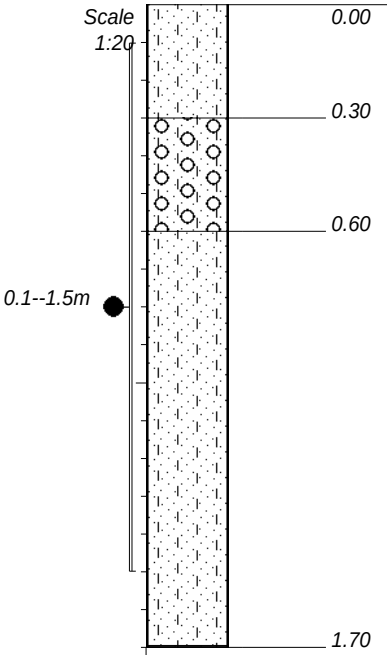
HOLE No: TP18

Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP19
Sheet 1 of 1

JOB NUMBER: 15/119/TP



Slightly moist light brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.

As above but contains abundant fine to coarse quartz gravel. Pebble marker.

Moist orange brown speckled yellow brown dark brown medium dense to dense and dense in places jointed silty sand. Residual granite with scattered zones of reworked residual granite.

NOTES

1) Refusal at 1,7m on very soft rock granite.

2) No evidence of water.

3) Disturbed sample taken at 0,1--1,5m.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP19

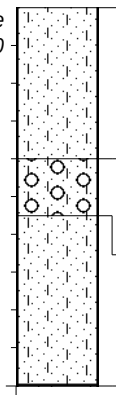
Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

HOLE No: TP20
Sheet 1 of 1

JOB NUMBER: 15/119/TP

Scale 1:20



0.00	Slightly moist dark brown loose to medium dense intact silty sand. Hillwash. Also contains abundant roots in the upper 0,15m.
0.40	As above but contains abundant fine to coarse quartz gravel. Pebble marker.
0.55	Slightly moist orange brown speckled off white dark brown dense jointed silty sand. Residual granite.
1.00	

NOTES

1) Refusal at 1,0m on very soft rock granite.

2) No evidence of water.

CONTRACTOR :
MACHINE : Cat 522E
DRILLED BY :
PROFILED BY : Justin Davel

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 17/07/2015

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP20

Crossman, Pape and Associates
Consulting Geotechnical Engineers and Engineering Geologists

Zitholele Consulting
10ML Resevoir Carlswald

LEGEND
Sheet 1 of 1

JOB NUMBER: 15/119/TP

	GRAVEL	{SA02}
	SAND	{SA04}
	SILTY	{SA07}
Name ●	DISTURBED SAMPLE	{SA38}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Renee
SETUP FILE : STANDARD.SET

DATE : 06/08/2015 12:17
TEXT : ..OMLResevoirCarlswald.txt

LEGEND
SUMMARY OF SYMBOLS

PORTION 4: STANDARD JOHANNESBURG WATER SPECIFICATIONS

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 3 : PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 3 : Programmable Logic Controller (PLC) Panels**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 3**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	15	C. Du Toit	Cover page updated
2019-06-25	14	C. Du Toit	Added stopper plugs, fan terminations, panel light and PLC panel earthing.
2018-11-30	13	C. Du Toit	Added spare space requirements, PLC fan position, terminal requirements, use of bolts, fused terminal
2014-04-17	12	C. Du Toit	PLC fan position and reference to SANS 10142 updated.
2013-10-07	11	C. Du Toit	Updated footer, screws in backing plates and PLC fan requirements.
2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Altered I/O card terminal requirements and minimum panel powder coating thickness.
2010-03-12	6	C. Du Toit	Altered submission time of PLC panel drawings.

2009-08-18	5	C. Du Toit	New logos added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

3 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS 5

3.1 Scope 5

3.2 Abbreviations 5

3.3 Standards 5

3.4 General Requirements 5

3.5 Standard Features 6

3.6 Wiring, Relays and Terminals 8

3.7 Existing PLC Panels 11

3.8 Factory Acceptance 11

3.9 Loop Isolators 11

3.10 Uninterruptible Power Supply (UPS) 11

3.11 Over-Voltage/Lightning Protection 11

3.12 Spares 12

3.13 Painting (Powder Coating Method) 12

3.14 Drawings And Diagrams 13

3 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

3.1 Scope

3.1.1 This specification covers the manufacturing, supply and installation of Programmable Logic Controller panels used for process monitoring and control applications at Johannesburg Water wastewater sites.

3.2 Abbreviations

3.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker

3.3 Standards

3.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

3.4 General Requirements

3.4.1 The PLC control panel shall house the following items:-

3.4.1.1 The PLC and all I/O modules and racks.

3.4.1.2 Fibre-optic network interface modules.

3.4.1.3 All network switches and hubs.

3.4.1.4 All field instrumentation and MCC interface cables shall be marshalled in this panel.

3.4.1.5 All power supply and distribution circuitry and equipment.

3.4.1.6 All lightning and surge protection devices as required.

3.4.1.7 Marshalling terminals as required

3.4.1.8 Interposing relays as required.

3.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.

3.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).

3.4.4 The panel should be manufactured from sheet steel not less than 2,0 mm thick. The panel will have a door on the front which opens to practically the full width and height of the panel. The panel shall be free standing and shall not be more than 2 200 mm high, 2 400mm wide and 600mm deep and it should be sized to accommodate all the PLC and associated equipment required for the actual PLC I/O and future spare capacity as indicated in the PLC schematic diagram.

3.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.

3.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white. All removable parts and hardware will be cadmium yellow passivized.

3.4.7 Each panel and control function should be clearly labelled with labels engraved on laminated engraving board with black letters on a white background. All labels must be attached with chrome plated, screws and nuts or screws and tapped holes. On the backing plate only tapped holes may be used. Screws with nuts on the backing plate will not be acceptable.

3.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 55.

3.4.9 This specification must be read in conjunction with the PLC Hardware Specification (Volume 2 of the Automation And Control Standards).

3.4.10 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

3.5 Standard Features

3.5.1 Each panel shall have the following features as standard:-

3.5.1.1 Ventilation fans with air filters shall be mounted on the PLC panel at high level with no air outlets. The fans must pressurise the panel to prevent the ingress of dust.

3.5.1.2 Ventilation fans must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

3.5.1.3 A 230V AC switch socket outlet shall be mounted inside the panel (supplied from the UPS section). This socket must have a shaved earth which shall be used for the PLC programmer only.

3.5.1.4 Interior lighting at the top of the panel must be arranged to switch on, via a micro switch, when the panel door is opened. This light must be an LED

light with a CCT (Correlated Colour Temperature) of 4000K to 6000K. The light must be fitted with a diffuser and it must supply no less than 680 lm (Net luminous flux). The lamp must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

3.5.1.5 A substantial area of removable gland plates on the floor of the panel, split into two or more sections.

3.5.1.6 A sheet steel pocket welded onto inside of the door to hold A4 sized drawings, books etc.

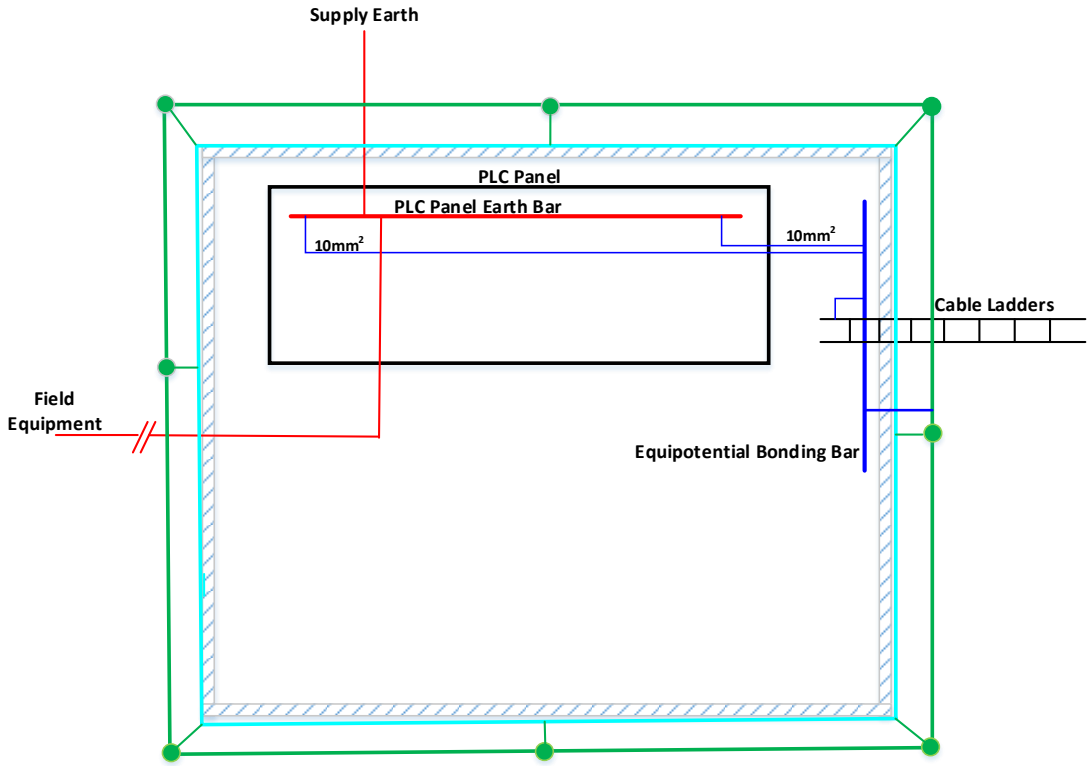
3.5.1.7 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the panel is not compromised.

3.5.1.8 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.

3.5.1.9 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

3.5.1.10 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

3.5.1.11 A copper earth bar running the full width (i.e. left-end to right-end) of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires. This earth bar must be connected to the equipotential bonding bar of the building via at least 2 x $10mm^2$ earth conductors (one from each end of the panel earth bar), as shown in the sketch below.



3.5.1.12 Separate AC and DC distribution sections if both AC and DC are used.

3.5.1.13 A free-standing (i.e. not the PLC rack mounted) 24V DC Power supply for all analogue I/O cards or I/O sub-bases (where required), 24V DC I/O distribution (if required), field instrumentation supplies (if required), etc.

3.5.1.14 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).



3.6 Wiring, Relays and Terminals

3.6.1 All terminals shall be screw-type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.

3.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

3.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).






3.6.4 Every wire shall be marked at both ends with a numbering system approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug.

3.6.5 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-

3.6.5.1 1,5mm² for 230V AC or 110V AC power

3.6.5.2 1,0mm² for 24V DC or AC power

3.6.5.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals

3.6.5.4 4,0mm² for earth drain

3.6.6 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in the latest version of SANS 10142.

3.6.7 All wire terminations must be done by using suitable lugs. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

3.6.8 All panel wiring shall run in suitably sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.

3.6.9 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.

3.6.10 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.

3.6.11 A block of terminals shall be allocated to each I/O module. The terminal block shall be labelled with the PLC rack number and module slot allocation.

3.6.12 The terminals allocated for the various I/O modules must be as per the design drawings submitted by the Engineer. If it forms part of the contractor's scope of work to submit design drawings, the terminals allocated for the various I/O modules must be approved by the Engineer. All terminals shall be sequentially numbered from top to bottom for each I/O channel for every type of I/O card.

3.6.13 Each analogue and digital input and output channel shall have surge protection units as specified in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

3.6.14 Internal wiring shall be colour coded as follows:-

3.6.14.1 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

3.6.14.2 24V DC Power

Positive	Red
Negative	Black

3.6.14.3 Digital Inputs

230V AC	Yellow
24V DC	Red

3.6.14.4 Digital Outputs

230V AC	Grey
24V DC	Red

3.6.14.5 Relay Outputs

230V AC	Grey
24V DC	Red

3.6.14.6 Analogue Signals

Positive	Orange
Negative	Purple

3.6.15 A terminal section for AC and DC power distribution shall be included in the PLC panel where both voltages are used for PLC I/O. The terminal groups shall be clearly identified to indicate the various voltages.

3.6.16 A separate power distribution section shall be used for the AC and DC supplies where both voltages are used. Miniature circuit breakers (MCB's) shall be used to feed the various items of equipment such as PLC I/O cards, fans, lights, field instruments, etc. Fused terminals may be used if it is indicated as such on the design drawings submitted by the Engineer.

3.6.17 Two types of mains supplies shall be made available to the PLC panels: Raw Mains and UPS Mains. The raw mains incomer shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules, etc. The UPS supply shall feed the critical items required for PLC communications in the event of a raw mains power supply interruption. Such items are plugs (for PC), lights (inside the PLC panel), fibre-optic interface modules, PLC Processor, etc. Unless otherwise specified, PLC I/O and field instruments need not be supplied by UPS power.

3.6.18 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.

3.6.19 Where relays (not relays that are part of the PLC hardware, such as in I/O sub-bases) are used, such relays must be pluggable, so that relays can be replaced

without the need to disconnect wiring and the relays must have visible indication when it is energised.

3.7 Existing PLC Panels

3.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

3.8 Factory Acceptance

3.8.1 Before delivery of the PLC systems and/or the PLC panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

3.8.2 The test shall comprise of at least, but not be limited to:

3.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.

3.8.2.2 Layout, numbering and labelling of equipment.

3.8.2.3 Wiring – sizes, numbering, colours, termination, etc.

3.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

3.9 Loop Isolators

3.9.1 Loop isolators are required where the instruments and the relevant PLC are fed from different power sources. Loop isolators must provide isolation between the instrument signals and the power supply. Separately powered isolators are preferred.

3.10 Uninterruptible Power Supply (UPS)

3.10.1 An Uninterruptible power supply must be installed to isolate the PLC from the "raw" mains supply.

3.10.2 The UPS must comply with the UPS requirements as specified in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.10.3 The raw mains incomer to the PLC panel shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules (if required), etc. The UPS supply shall feed the critical items that keep PLC communications established should the raw mains power supply be interrupted, such as plugs, lights, fibre-optic interface modules, PLC (CPU), etc.

3.10.4 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

3.11 Over-Voltage/Lightning Protection

3.11.1 The function of the over-voltage/lightning protection units is to prevent damage

from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.11.2 The protection units on the 230V AC mains incomers of the PLC panel (if not provided on the mains elsewhere) shall consist of at least IEC Class II protection. Preferably Class I and Class II, or a combined Class I + Class II protection must be used.

3.11.3 Each individual supply from the 24V DC distribution and from the 230V AC distribution to field instruments or other field supplies must be equipped with at least Class II medium surge protection.

3.12 Spares

3.12.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

3.13 Painting (Powder Coating Method)

3.13.1 **General**

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.
Unless specified otherwise, a high gloss finish in the following colour shall be provided:
Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.
Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

3.13.2 **Specifications**

The following specifications in accordance with SANS 1274-2005 shall be provided:-

Property	Requirement	Test Method
Thickness, minimum	50 micron	6,7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13
Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

3.13.3 **Surface Preparation**

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.

All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.
A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.
Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned. These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.
The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

3.13.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185ºC so as to melt the powders to form a continuous film over the metal substrate.

3.14 Drawings And Diagrams

3.14.1 The tenderer must submit layout drawings, showing the PLC panel size, cable entry, location of equipment, details of equipment (such as fans, lights, plugs, trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm mild steel), etc. for approval by the Engineer before any manufacturing commences.

3.14.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Terminals - Phoenix SK12, 4mm, white.
MCB’s - Merlin Gerin, 5A, 10kA, single-pole.
Etc.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 5 : CLEAN POWER AND SURGE PROTECTION

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 14 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 5 : Clean Power And Surge Protection**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 5**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
2019-06-15	13	C. Du Toit	Revision approved by JW
2018-11-30	12	C. Du Toit	Requirements for static and manual bypass switches on UPS corrected & added reference to Labelling
2014-04-17	11	C. Du Toit	Added more detail to "transformer-based" UPS description
2013-10-07	10	C. Du Toit	Updated numbering in item 5.7 and clarified "transformer-based" UPS
2013-02-04	9	C. Du Toit	Updated Footer
2012-07-27	8	C. Du Toit	Updated headers & footers.
2012-03-08	7	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	6	C. Du Toit	Altered rated operating current for SPDs, added data sheets & removed 2010 logo.
2009-08-18	5	C. Du Toit	Logos altered and UPS size altered.

2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2007-11-22	3	C. Du Toit	Item number referred to in item 5.11.3 corrected.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

5 CLEAN POWER AND SURGE PROTECTION 4

5.1 Scope 4

5.2 Abbreviations 4

5.3 Standards 4

5.4 Uninterruptible Power Supply (UPS) General Requirements 5

5.5 UPS Rating 6

5.6 UPS Backup Batteries 6

5.7 UPS Standards 6

5.8 UPS Data Sheets 7

5.9 Surge Protection General 8

5.10 Surge Protection On Mains Power 11

5.11 Surge Protection On Field I/O 12

5.12 Surge Protection Data Sheets 17

5 CLEAN POWER AND SURGE PROTECTION

5.1 Scope

5.1.1 This specification covers the selection, installation, testing, marking and termination of Uninterruptible Power Supplies and Surge Protection used for low voltage power and control installations at Johannesburg Water wastewater sites.

5.2 Abbreviations

5.2.1 In this specification the following abbreviations will apply :-

SANS	:	South African National Standards
IEC	:	International Electrotechnical Commission
PLC	:	Programmable Logic Controller
UPS	:	Uninterruptible Power Supply
CE	:	Official marking to indicate compliance with essential requirements of European Union directives
LGA	:	Local Government Association
GS	:	Geprüfte Sicherheit ("Tested Safety") is a voluntary certification mark
EMC	:	Electromagnetic Compatibility
EN	:	British Standard (BS EN)
PWM	:	Pulse Width Modulation
THD	:	Total Harmonic Distortion
Vpc	:	Volts per cell
Ah	:	Ampere hour
SPD	:	Surge Protection Device
LPZ	:	Lightning Protection Zone
ICASA	:	Independent Communication Authority of South Africa

5.3 Standards

5.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 61643-1	:	Surge protection devices – performance requirements and testing methods
IEC 61643-1	:	Surge protection devices – performance requirements and testing methods
EN 50091-1, -2	:	General and safety requirements for UPS
EN 61000-3-2	:	Limits for harmonics

5.4 Uninterruptible Power Supply (UPS) General Requirements

5.4.1 The UPS must be a **TRUE** on-line, double conversion transformer-based unit (i.e. using a transformer which is an integral part of the UPS, on the **input** to the UPS). Hybrids, transformerless units or units with external, separate transformers will not be acceptable.

5.4.2 The UPS must employ PWM technology.

5.4.3 The UPS must have battery backup for at least 30 minutes at the **FULL RATED LOAD** of the UPS.

5.4.4 The output wave form shall be sinusoidal in form with the THD at full line load not exceeding 3%.

5.4.5 The output voltage variation must not exceed 2%.

5.4.6 Interference shall not exceed the limits laid down by ICASA.

5.4.7 The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.

5.4.8 The UPS must be accompanied by the tenderer's proof of their ability to install, test, service, repair, etc. these devices in the field and that they have a suitable after-sales infrastructure.

5.4.9 The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.

5.4.10 The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.

5.4.11 The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.

5.4.12 If it is an imported UPS, the vendor must be the **ACTUAL** importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.

5.4.13 A voltage free contact rated for 230V AC at 2 amps shall be provided in all the UPS units. This general alarm relay shall be internally wired to energise when a collective signal from all alarms is healthy. Alternatively, this relay shall de-energise when a fault occurs, raw mains is interrupted or the battery power is low.

5.4.14 The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.

5.4.15 The UPS system shall be suitable for operation from a 230V AC single phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.

5.4.16 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

5.4.17 The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.

5.4.18 The UPS must be able to operate normally in an ambient service temperature of 0ºC to +35ºC and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.

5.4.19 The rated output voltage must be user selectable from 220/230/240V.

5.4.20 The output frequency must not vary by more than 3Hz.

5.4.21 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.5 UPS Rating

5.5.1 The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.

5.5.2 The UPS efficiency must be no less than 89% from zero to full load.

5.5.3 The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA.

5.6 UPS Backup Batteries

5.6.1 Tenderers must state the exact number of batteries that will be used.

5.6.2 Tenderers must state the type of batteries that will be used.

5.6.3 Tenderers must state the Ah rating of the batteries that will be used.

5.6.4 Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

5.7 UPS Standards

5.7.1 All imported UPSs must have a CE rating.

5.7.2 The UPS must have CE, LGA/GS markings.

5.7.3 The UPS must comply with safety conformance to EN-50091-1.

5.7.4 The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

5.8 UPS Data Sheets

5.8.1 The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	
Overload handling capabilities (E.g. “x”% load for “y” minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. “Yes, full compliance” or “No”.	
Tenderer to provide complete factory load test that can be witnessed by the Engineer?	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

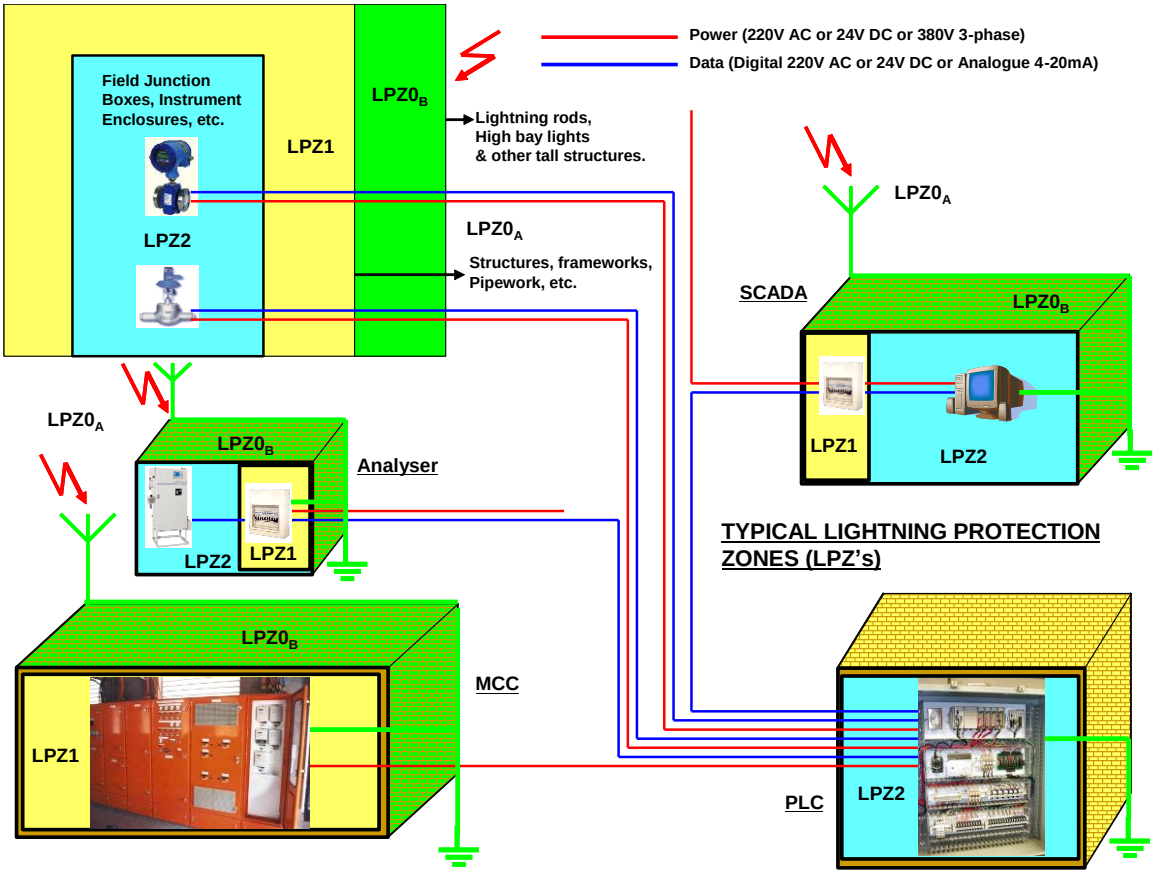
5.9 Surge Protection General

5.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.9.2 The **Protection Level** required (i.e. Level I, Level II or Level III-IV in accordance with Table L.2 in SANS 10142-1:2003 Annex L) needs to be established for every installation where there is doubt about these requirements. This requirement looks at the consequential loss resulting from potential lightning hazards. Generally for all JHB Water wastewater sites in the Gauteng area, Level III-IV will suffice. In other words, a lighting impulse level of 100kA (10/350µs) needs to be considered when designing protection systems.

5.9.3 The function of the Surge Protection Device (SPD) is to prevent damage from occurring to the electrical and electronic devices due to destructive currents and voltages arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must comply with SANS 10142-1:2003 Annex L, SANS 61643-1/IEC 61643-1 and any other specifications referred to in SANS 10142-1:300 Annex L.

5.9.4 The definition of lightning protection zones (LPZs), as specified in SANS 61643-1/IEC 61643-1, must be used to determine the **Class** of SPD to be used (i.e. Class I, Class II or Class III in accordance with SANS 61643-1/IEC 61643-1). These classes (also referred to as IEC Classes or IEC Category Classes or Types) define the surge handling ability which SPDs must have for use in each Class.



5.9.5 Notwithstanding the requirements of SANS 10142-1:2003 Annex L, the surge handling ability of the SPDs installed in the various LPZs for JHB Water applications must be as follows:

At the Interface Between:	IEC Class SPD Required	Min. Required SPD Rating
LPZ 0_A and LPZ 1	Class I	For Single Units: I_{imp} = 50kA (10/350 µs) for SPDs between PHASE and NEUTRAL I_{imp} = 100kA (10/350 µs) for SPDs between NEUTRAL and PE and For Combination Units: I_{imp} = 25kA (10/350 µs) per channel
LPZ 0_B and LPZ 1	Class II	I_{sn} = 20kA (8/20 µs) for SPDs between PHASE and NEUTRAL I_{sn} = 12kA (10/350 µs) for SPDs between NEUTRAL and PE
LPZ 1 and LPZ 2	Class III	I_{sn} = 5kA (8/20 µs)

Where: I_{imp} = The standard impulse current curve with a 10/350 µs waveform
I_{sn} = The nominal discharge current or peak value of the current flowing through the SPD. It has an 8/20 µs impulse current waveform.

5.9.6 All SPDs used must limit the voltage to less than two times the nominal operating voltage for systems below 60V (AC or DC) and for systems above 60V it must limit the voltage to the values given in Table L.1 in SANS 10142-1:2003 Annex L.

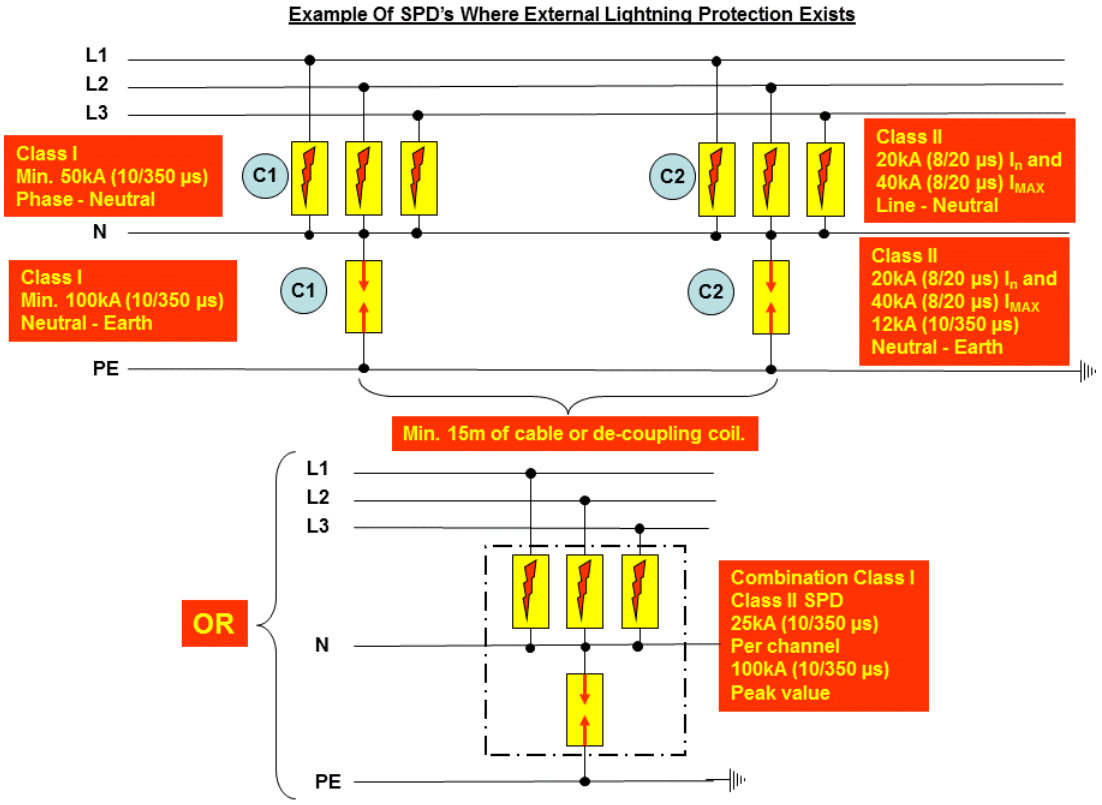
5.9.7 In order to ensure that individual protective devices are selectively effective, i.e. each protection stage only takes on the amount of interference energy which it is designed for, if one protection stage is faced with the threat of an energy overload, the upstream, more powerful arrester must “respond” and thus take over the discharge of the interference energy.

5.9.8 Even though surge arresters (i.e. Class II and Class III devices), by definition, are only tested to pulse waveforms of 8/20 µs, it is imperative to determine the ability of the device to carry an impulse current of the partial lightning currents with the waveform 10/350 µs for the co-ordination between surge arrester (i.e. Class II and Class III devices) and lightning current arrester (i.e. Class I devices), and also for the SPD.

5.9.9 All SPDs must be DIN rail mounted.

5.9.10 Should the building (where the PLC, distribution board, etc. and surge protection is installed) have external lightning protection, then a combination of Class I lightning current arresters (min. rating of 50kA (10/350 µs) each phase to neutral) plus one Spark Gap (min. rating of 100kA (10/350 µs) neutral to earth) and Class II nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs) surge arresters must be installed as per SANS 10142-1:2003 Annex L (see the diagram below). In all other cases a minimum of Class II SPDs are required.

5.9.11 These surge arresters (Class I and II or combination Class I/Class II above) must be installed from each Phase to Neutral and from Neutral to Earth. It must be borne in mind that if Class I **and** Class II SPDs are used, a minimum of 15m of cabling is required between these two systems for de-coupling. Another alternative is to use the correct coils available on the market to simulate the 15m difference. Preference will however be given to **combination** Class I and Class II units with pluggable modules because this eliminates coils and long cables and it allows replacement/inspection without the need to disconnect cables.



5.9.12 For Class I lightning arresters the minimum conductor size is 16mm^2 and pre-fusing of 315 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

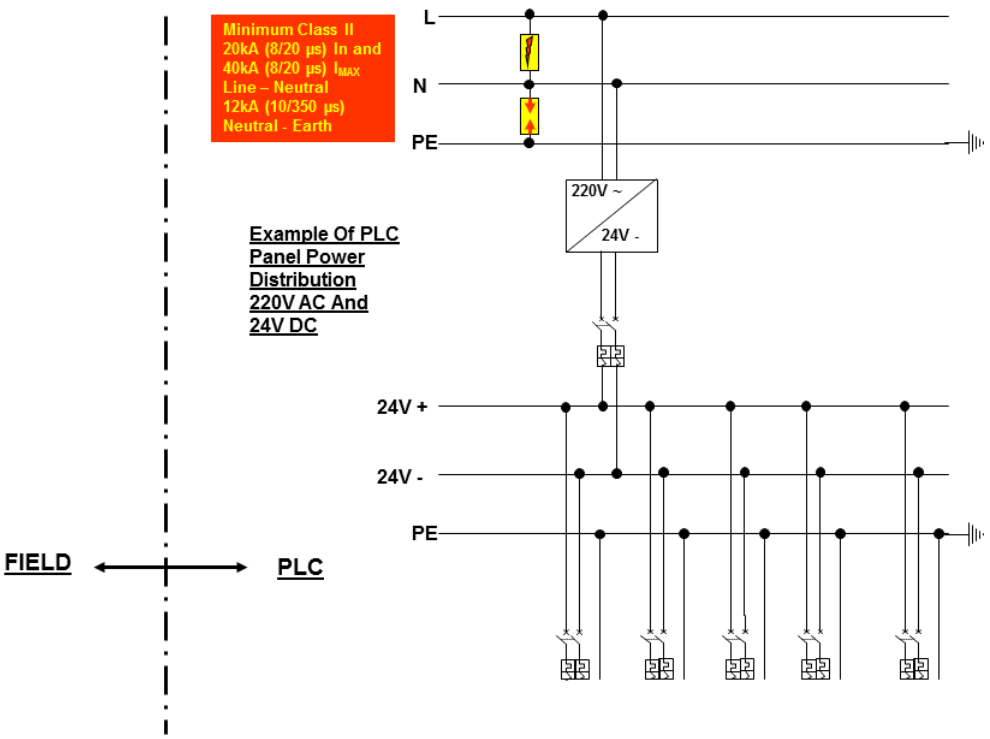
5.9.13 For Class II the minimum conductor size is 6mm^2 and pre-fusing of 125 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.

5.10 Surge Protection On Mains Power

5.10.1 If there is no external lightning protection on the building, the protection units on the mains supply of the PLC panel must consist of at least IEC Category Class II, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current I_n = 20kA (8/20 µs) and maximum discharge current I_{MAX} = 40kA (8/20 µs), surge arrester from neutral to earth (same arrangement as the example shown above).

5.10.2 All the surge arresters must be DIN rail mounted and must comply with IEC 61643-1 (other designations, SANS 61643-1 and SANS IEC 61643-1) and there must be visual indication if the unit is over stressed (i.e. it has failed).

5.10.3 The spark gap must be able to withstand surges of 12kA (10/350 µs) and must specifically bond between neutral and earth.



5.11 Surge Protection On Field I/O

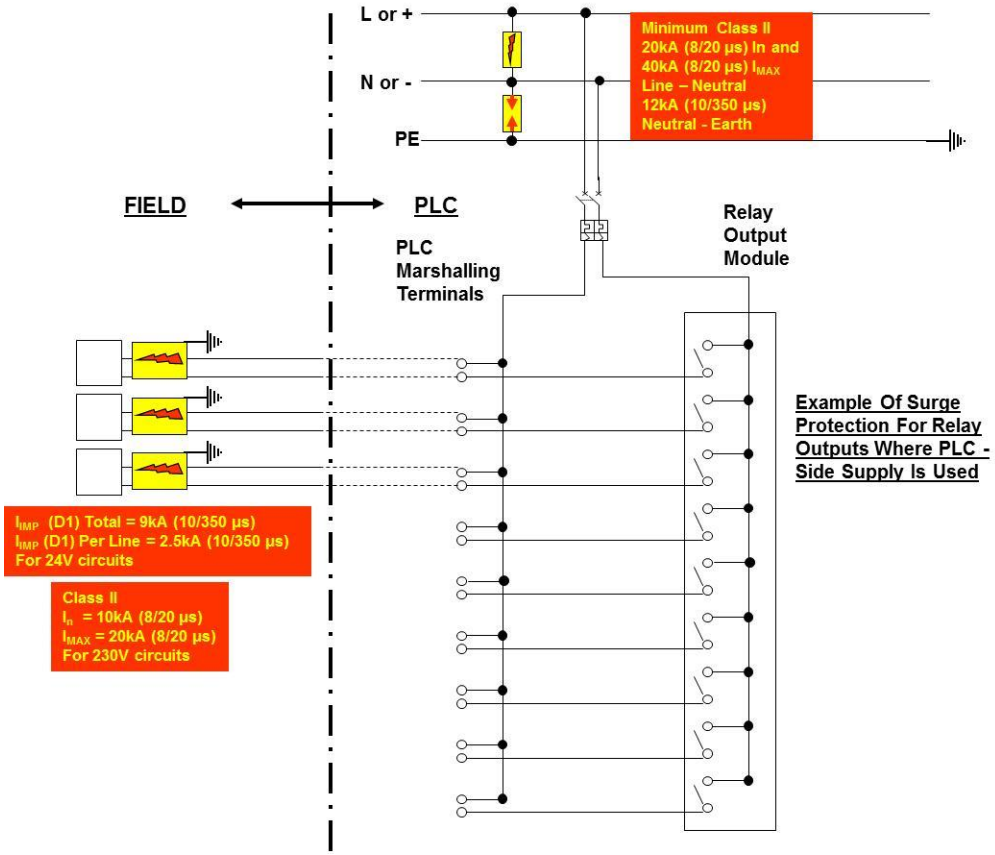
5.11.1 SPDs used for data protection (i.e. of digital and analogue I/O connected to devices outside the PLC building where induced voltages and currents are possible) must be designed to repeatedly withstand direct lightning currents I_{imp} of 2.5kA (10/350 µs) per line and nominal (i.e. peak) surges I_{sn} of 20kA (8/20 µs) for 4-20mA control loops, 24V DC digital and analogue systems and 24V AC systems. SPDs used for 230V AC digital I/O connected to devices outside the PLC building where induced voltages and currents are possible, must be designed to repeatedly withstand nominal discharge currents I_n of 10kA (8/20 µs) and maximum discharge currents I_{max} of 20kA (8/20 µs). These 230V AC SPDs must be rated at least Class II according to IEC 61643-1 or Type 2 according to IEC 61643-11.

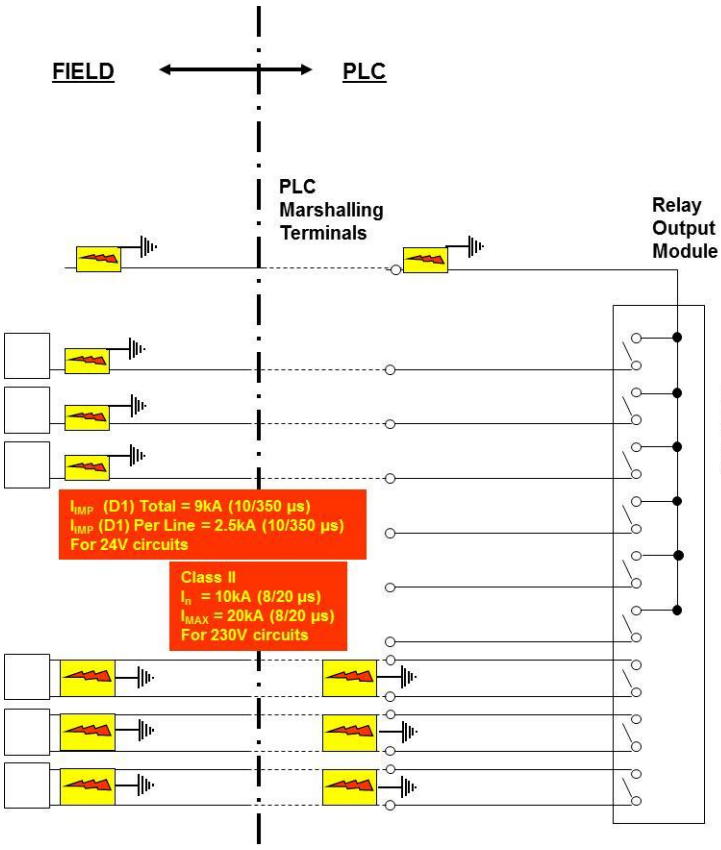
5.11.2 SPDs must be installed at both ends of each cable (i.e. at the PLC and at the field instrument, MCC, control panel, junction box, etc).

5.11.3 The LPZ in which the instrument, instrument distribution board or instrument junction box is, must be used to determine the ratings of the SPD. The ratings on digital and analogue I/O protection must just never be lower than the ratings mentioned in item 5.11.1 above.

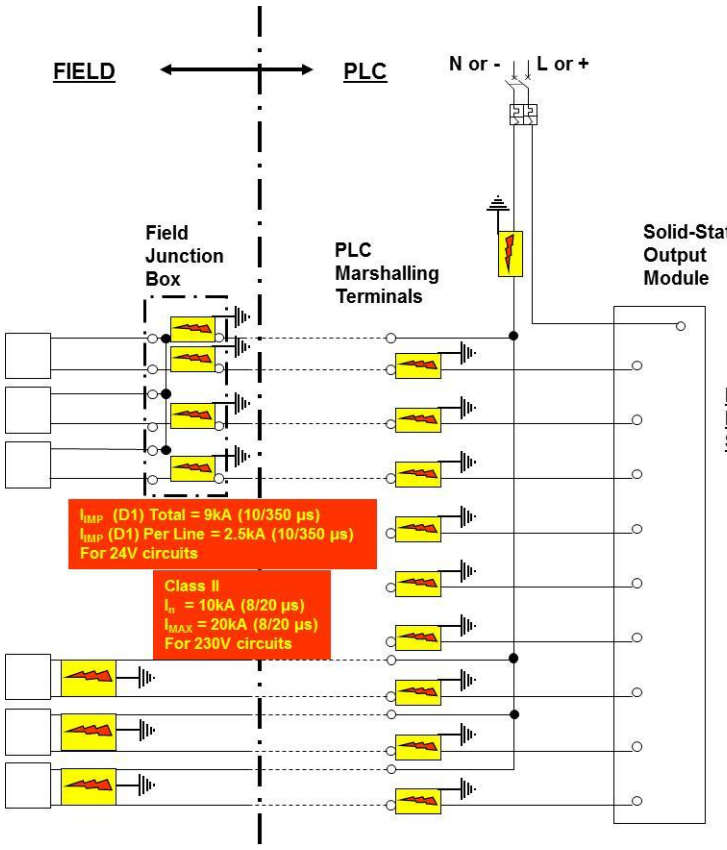
5.11.4 The rated operating current for SPDs used for protection of I/O systems must not be less than 0.75Amp.

5.11.5 All SPDs must consist of a base and a pluggable top which can be disconnected without interrupting the signals.

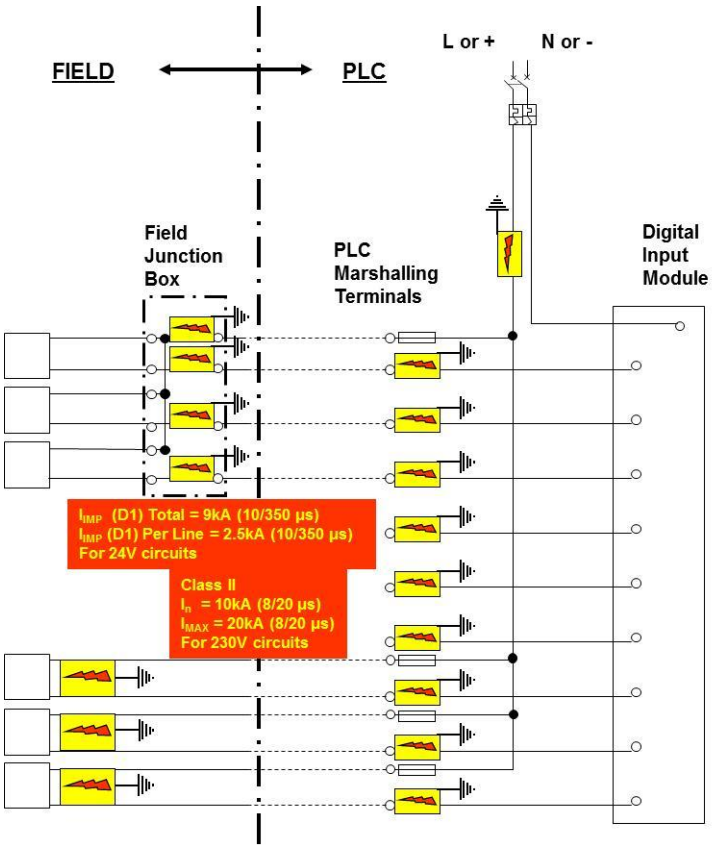

L or +
N or -
PE
Minimum Class II
20kA (8/20 µs) In and
40kA (8/20 µs) IMAX
Line – Neutral
12kA (10/350 µs)
Neutral - Earth
FIELD
PLC
PLC
Marshalling
Terminals
Relay
Output
Module
IIMP (D1) Total = 9kA (10/350 µs)
IIMP (D1) Per Line = 2.5kA (10/350 µs)
For 24V circuits
Class II
In = 10kA (8/20 µs)
IMAX = 20kA (8/20 µs)
For 230V circuits
Example Of Surge
Protection For Relay
Outputs Where PLC -
Side Supply Is Used



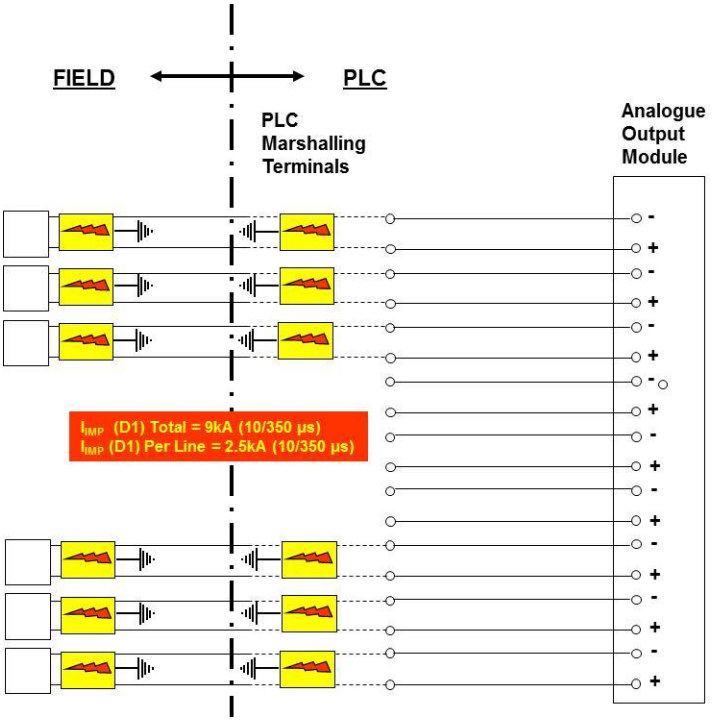
Example Of Surge Protection For Relay Outputs Where External Supply Is Used



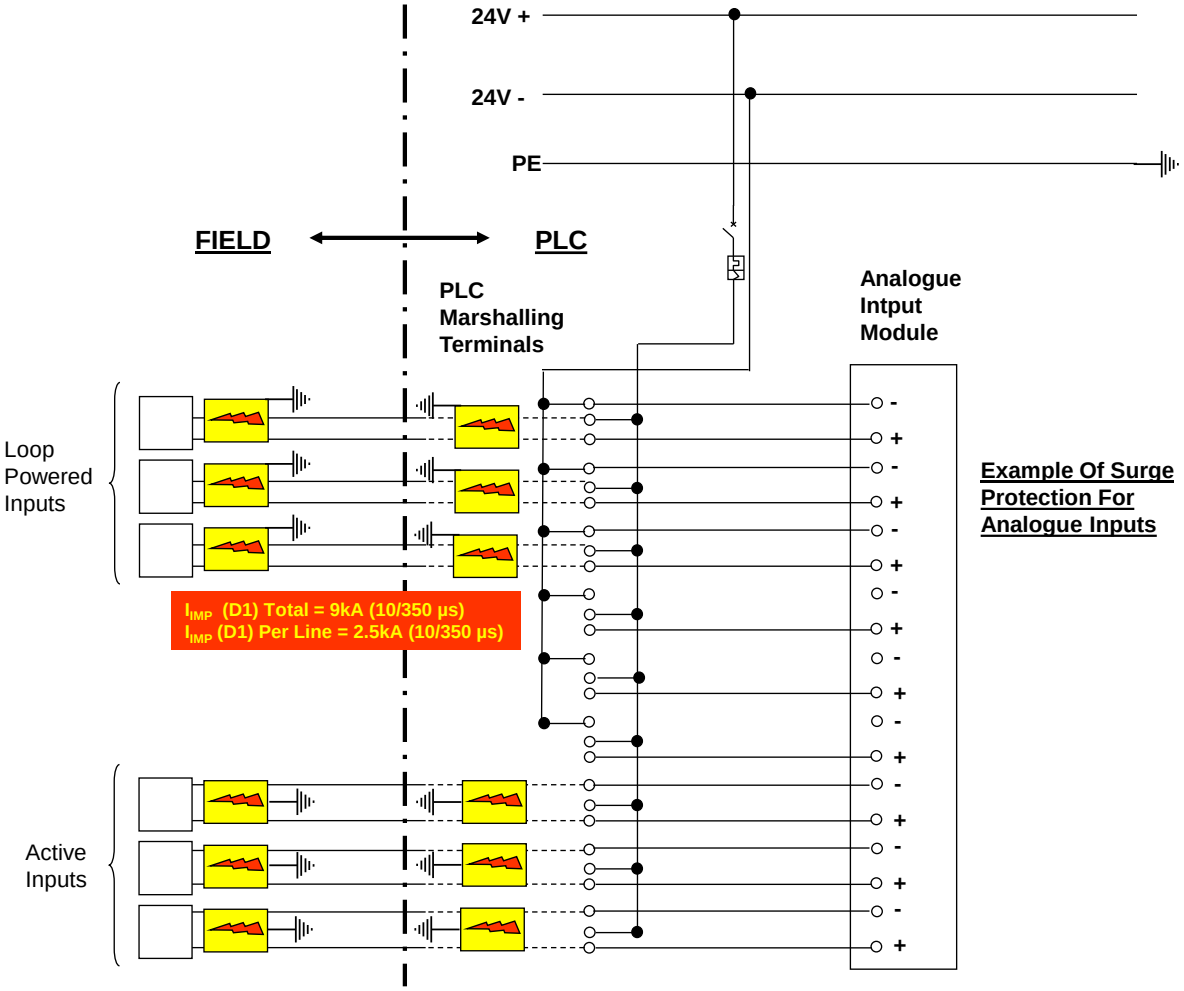
Example Of Surge Protection For Solid State Outputs



Example Of Surge Protection For Digital Inputs



Example Of Surge Protection For Analogue Outputs


24V +
24V -
PE
FIELD
PLC
PLC
Marshalling
Terminals
Analogue
Intput
Module
Loop
Powered
Inputs
Active
Inputs
I_IMP (D1) Total = 9kA (10/350 µs)
I_IMP (D1) Per Line = 2.5kA (10/350 µs)
Example Of Surge
Protection For
Analogue Inputs

5.12 Surge Protection Data Sheets

5.12.1 The tenderer must complete the relevant data sheets below with his tender:

Technical Data Sheet: Mains Surge Protection

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Surge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 230V Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Discharge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 24V DC Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection Analogue I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 6 : CABLING

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 17 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 6 : Cabling**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 6**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	17	C. Du Toit	Cover page updated
2019-08-14	16	C. Du Toit	Updated materials for use in corrosive areas (GRP).
2019-06-15	15	C. Du Toit	JW comments included (Trenching under roads, sleeve draw wires, route marker painting, manhole covers and
2018-11-30	14	C. Du Toit	Added maximum losses for OTDR & OLTS testing, standards for data cable testing, protective tiles and
2014-04-17	13	C. Du Toit	Added blown fibre, splicing requirements & laser safety.
2013-10-07	12	C. Du Toit	Updated footer, bends for cable racks, cores in fibre-optic cables, fibre-optic cable type, earthing for theft
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Updated support material for Ferric Chloride areas.
2012-03-08	9	C. Du Toit	Altered height of cable route markers, added new wiring size requirements and precedence of wiring sizes,
2011-07-11	8	C. Du Toit	Added cable theft prevention measures and removed 2010 logo.

2010-07-27	7	C. Du Toit	Added details of cable route markers and updated materials for cable ladders.
2009-08-18	6	C. Du Toit	Added new logos, cable rack material & colour and warning tape in trenches.
2009-05-08	5	C. Du Toit	Added requirements from client meeting on 04 May 2009.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

6 CABLING 4

6.1 Scope 4

6.2 Abbreviations 4

6.3 Standards 4

6.4 General 5

6.5 Cabling On Racks And Supports 11

6.6 Electric Cable Terminations 13

6.7 Cables, Sleeves Or Microduct Assemblies In Trenches 14

6.8 Fibre-Optic Data Cable Terminations 18

6.9 Copper Data Cables 21

6.10 Data Cabling General 22

6.11 Cable Theft Prevention Measures 22

6 CABLING

6.1 Scope

6.1.1 This specification covers the selection, installation, testing, marking and termination of electrical cables used for low voltage power and control installations as well as fibre-optic and copper cables for data transmission, used in process monitoring and control applications at Johannesburg Water wastewater sites.

6.2 Abbreviations

6.2.1 In this specification the following abbreviations will apply :-

SANS	:	South African National Standards
IEC	:	International Electrotechnical Commission
EN	:	Standards from the European Committee for Standardization
PLC	:	Programmable Logic Controller
UV	:	Ultra Violet
PVC	:	Poly Vinyl Chloride
OTDR	:	Optical Time Domain Reflectometer
OLTS	:	Optical Loss Test Set
SFP	:	Small Form Pluggable

MRM Ref. No. : The nominal mass in kg/m^2 multiplied by 100, used for steel wire mesh reinforcing.

6.3 Standards

6.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises
SANS 1507	:	Electric Cables (300/500V to 900/3300V)
SANS 1574	:	Electric Cables Flexible cords and flexible cables
SANS 1411-1 to 7	:	Material of insulated electric cables and flexible cords
SANS 1507-1 to 3	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V)
SANS 1803-1	:	Lugs and ferrules for insulated cables
SANS 60793	:	Optical fibres
SANS 1024:2006	:	Steel wire mesh
IEC 60793	:	Optical fibres
SANS 60794	:	Optical fibre cables
IEC 60794	:	Optical fibre cables

ISO/IEC 14763-3	:	Fibre optic testing
TIA/EIA 568-B.2-10	:	Copper data cable testing
EN 50288	:	Multi-element metallic cables used in analogue and digital communications and control
ISO/IEC SANS 11801:2002	:	Information Technology – Generic cabling for customer premises
IEC 60332-1	:	Flammability of a single vertical cable

6.4 General

6.4.1 All cables and wiring supplied must be supplied complete with fittings, accessories, etc.

6.4.2 The installation of all wires and cables must comply with SANS 10142-1:2003 and SANS 1507-1 to 3, all as amended.

6.4.3 The installation of flexible cords must comply with SANS 1574:2004 as amended.

6.4.4 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must have untinned, annealed, multi-strand copper conductors and must comply with, SANS 1507-2 and SANS 1507-3: 2002 as amended.

6.4.5 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must comply with the latest edition of SANS 1411-1 to 7 in terms of material of construction. The sheath of these cables must be an impermeable, halogen-free, reduced smoke emission, flame retardant, UV stabilised compound in accordance with the latest edition of SANS 1411.

6.4.6 All fibre-optic cables must comply with SANS 60793-1 for measurement and test methods, SANS 60793-2 for product specifications and SANS 60794 for generic, sectional and family specifications.

6.4.7 All blown fibre-optic installations must comply with the requirements of SANS 60794-5 which specifies the requirements of microduct optical fibre cables, microduct fibre units, microducts and protected microducts for installation by blowing for outdoor and/or indoor use.

6.4.8 All fibre-optic micro cables must comply with the requirements of SANS 60794-5-10 and all blown fibre-optic bundles must comply with the requirements of SANS 60794-5-20.

6.4.9 All blown fibre installations must be done by people who can provide proof of certified training by a recognized supplier/installer such as Lonspeare SA (Pty) Ltd. or equivalent.

6.4.10 Where fibre-optic data communication is employed, blown fibre installations will be the preferred method. Only where the use of fibre-optic cabling is unavoidable, will such cabling, instead of blown fibre assemblies be accepted.

6.4.11 All wires and cables must be from fresh stock, with the manufacturer’s original wrappings, labels and seals intact when delivered to site.

6.4.12 All cables must be inspected for visible defects or signs of damage before installation. A

checklist of cables checked for visible defects/damage must be available on request.

6.4.13 All cable ends must be sealed or capped immediately after cutting to prevent ingress of moisture, dirt, impurities, etc. This applies to cables to be installed as well as cable remaining on the drum.

6.4.14 Where cables or wires of different voltages run in the same trunking, cable trays, cable racks or cable supports, all insulation must be rated for the highest voltage being conducted.

6.4.15 For PLC panel wiring, this specification must be read in conjunction with the PLC Panels Specification (Volume 3 of the Automation And Control Standards).

6.4.16 All electrical and instrumentation cables must be tested, and the results recorded, for insulation resistance and conductivity in accordance with SANS 1507-3:2002 as amended, before installation and again before final termination. Rectification of faults in cables before final termination will be for the contractor's account.

6.4.17 For PLC I/O wiring, the minimum conductor size shall be 0.5mm^2 but contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.

6.4.18 All wiring for PLC panels, junction boxes, control panels, etc. shall be flexible, untinned, annealed, multi-strand copper wire of not less than:-

6.4.18.1 6mm² for 230V AC power between the main incoming circuit breaker of the PLC panel and the distribution AC circuit breakers.

6.4.18.2 4mm² for 24V DC power between the main DC circuit breaker of the PLC panel and the distribution DC circuit breakers.

6.4.18.3 1,5mm² for 230V AC or 110V AC power from below the distribution circuit breakers.

6.4.18.4 1,0mm² for 24V DC or AC power from below the distribution circuit breakers.

6.4.18.5 0,5mm² for all PLC I/O wiring between modules and marshalling terminals.

6.4.18.6 4,0mm² for earth drain.

6.4.19 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended. If wiring of greater cross-sectional area than the sizes indicated in item 6.4.17 and 6.4.18 above are indicated on project design drawings, the larger wiring sizes will take precedence.

6.4.20 All wires and cable cores must be fitted with suitable lugs at the end of each wire or core. The fitting of lugs and ferrules must comply with SANS 1803-1:2002 as amended. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

6.4.21 The use of lugs and ferrules must comply with SANS 1803-1:2002 as amended.

6.4.22 The outer sheath of all power cabling must be black and the outer sheath of all instrumentation and control cabling must be orange. The power supply to instruments

and transmitters are regarded as part of the instrumentation cabling and must therefore have an orange outer sheath. The outer sheaths of all blown fibre microduct assemblies must also be orange. Where blown fibre microduct assemblies have an outer sheath of a specific material (such as UV protection) which is not available in orange, the contractor can apply to the Engineer for a concession to use the assembly as is and only attach an orange heat-shrink (for identification purposes) at the ends where terminations are made.

6.4.23 The jacket or buffer tubes of fibre cores in fibre-optic cables must be colour coded and terminated in the following sequence:

Fibre/Tube	Colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

6.4.24 All fibre-optic cable will be CST (corrugated steel tape) or steel wire armoured, rodent-proof, UV protected, loose-tube, water blocking, suitable for use in direct burial and manufactured with an orange PVC sheath. The conductive steel armour of installed fibre cables shall be properly grounded to the protective earth at all termination points.

6.4.25 All blown fibre microduct assemblies installed in trenches must be suitable for direct burial in terms of strength and mechanical protection.

6.4.26 All blown fibre microduct assemblies installed on cable racks or supports above ground must have suitable mechanical protection. Suitable mechanical protection includes, blown fibre microduct assemblies on racks that are covered with metal covers, blown fibre microduct assemblies installed in metal tubing and blown fibre microduct assemblies with steel wire armouring or steel tape armouring.

6.4.27 Where blown fibre microduct assemblies are installed in buildings or in cable tunnels, such microduct assemblies must have an inner and outer sheath of fire retardant material. The outer sheath must also be low-smoke and halogen-free.

6.4.28 Where blown fibre microduct assemblies are exposed to direct sunlight, such microduct assemblies must have an outer sheath that is UV protected.

6.4.29 The contractor must take very careful note of the requirements for blown fibre microduct assemblies as outlined in items 6.4.25 to 6.4.28 above. These requirements imply that where the installation conditions change, suitable blown fibre microduct assemblies must be installed to suit the requirements of each section of the installation. The table below gives an example of the blown fibre microduct assembly requirements for various sections of an installation:

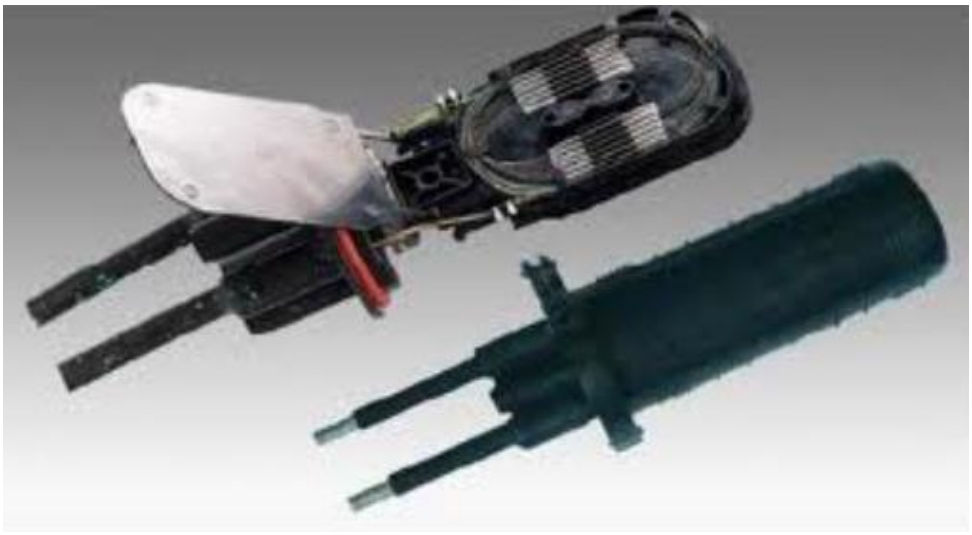
Installation Condition	Blown Fibre Microduct Assembly Requirem
In ceiling of a building	Rodent-proof, low-smoke, fire retardant, halogen
On a cable support against the side of the building	Steel wire or steel tape armoured, UV protected.
Buried in a trench	Suitable for direct burial.
On a rack in the open above ground	Mechanical protection, UV protection (if mechani protection is not steel covers or metal tubing).
On a rack inside a building	Mechanical protection, low-smoke, halogen-free, retardant.

6.4.30 All cables on racks, in trenches, in tunnels, in wire ways, on cable supports, etc. must be vermin-proof. I.e. such cables must be equipped with suitable armouring to prevent rodents or other vermin from chewing through core conductors or their insulation.

6.4.31 Bending of all cables and microduct assemblies for blown fibres must be limited to the safe criteria specified by the manufacturers.

6.4.32 Holes for cables or blown fibre microduct assemblies passing through walls, floors, partitions, ceilings, etc. must be done neatly and must be sealed off with plaster or filler as appropriate.

6.4.33 Splices in cables are prohibited, unless the route lengths exceed the maximum length of a drum or if the Engineer agrees to a splice. In such cases splices are to be made by using approved proprietary types of junction boxes, installed in an appropriate manner. For fibre-optic cables, dome splicing kits with a protection rating of at least IP68, installed in a manhole must be used. The dome splicing kit must be mounted vertically inside the manhole. The manhole must be big enough to create a 3m service loop in the each cable without exceeding the minimum bending radius of the cable and big enough to mount the enclosure appropriately in the manhole. Only fusion splices will be acceptable and ease of access to the splice must be ensured. Examples of such dome splicing kits are shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8 9 below must be complied with.







6.4.34 For blown fibre microduct assemblies, in-line splicing kits, installed in a manhole, can be used if a splice is approved by the Engineer. These kits must also have a protection rating of at least IP68. Only fusion splices will be acceptable and ease of access to the splice must be ensured. An example of such an in-line splicing kit is shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8 9 below must be complied with.



6.4.35 Splices in copper cables can be done with the aid of proprietary, resin-encapsulated splices that are completely water-proof (such as Scotch Cast or similar). Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level.

6.4.36 Manholes used for splicing can be constructed using bricks or concrete. The manhole must allow for adequate drainage of water. All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.

6.4.37 Cables or conductors passing through holes must be fully protected against damage by

correctly fitted grommets, bushes, etc.

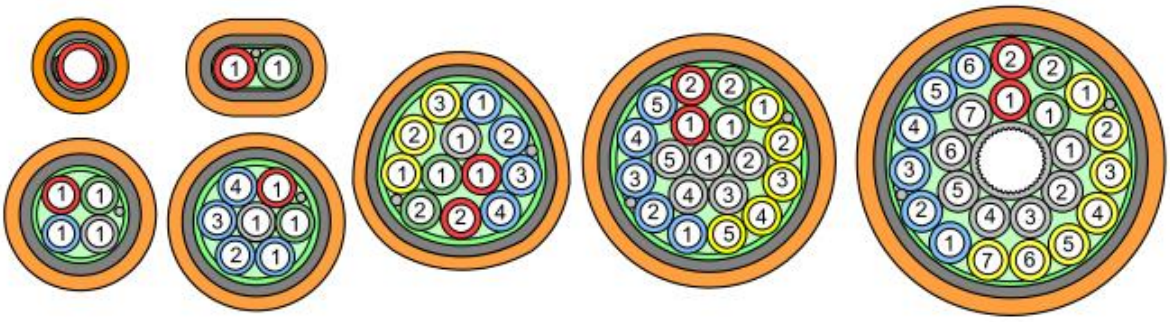
6.4.38 All cable routes, including trenches, cable racks, tunnels, cable supports, etc. must be clearly marked on drawings and submitted for approval by the Engineer. The project will not be regarded as complete until such cable route drawings have been submitted and approved.

6.4.39 The jacket or buffer tubes of fibre bundles used in blown fibre installations must be colour coded and terminated in the following sequence:

Fibre/Tube	Colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

6.4.40 The microducts (or inner tubes) of microduct assemblies used for blown fibre installations must be constructed from low-friction Poly Ethylene (PE). These microducts must be 5/3.5 in size (i.e. 5mm OD and 3.5mm ID). Surrounding the group of microducts, must be a layer of waterswell tape. Where steel wire armour or steel tape armour is not used, the microduct assembly must be metal-free.

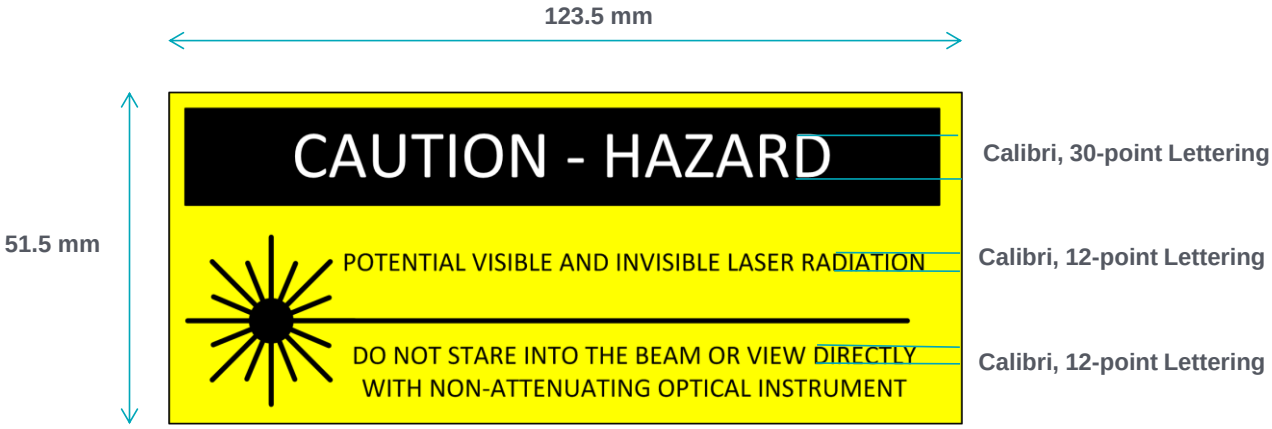
6.4.41 Microducts in microduct assemblies must be available in 1, 2, 4, 7, 12, 19 and 24 microduct assemblies and must be numbered and colour-coded as indicated in the sketch below.



6.4.42 The routes (i.e. source and destination) of microducts installed at each splice and/or termination must be noted down in detail during installation. This record must indicate for each fibre bundle that is blown into a microduct: Source – microduct colour – microduct number and Destination – microduct colour – microduct number. This detailed record must be submitted to the Engineer for approval before the blowing in of fibre bundles commences. Once it is approved, installation must be done according to this record. If a change is made, such a change must be recorded and a final “as-built” record of the installation must be produced for record purposes. The project will not be

regarded as complete until such microduct route records have been submitted and approved.

6.4.43 Wherever fibre-optic ends exist, such as at patch panels, splices, switches, transmitters, receivers, etc. and where it would be possible for a person to look into such fibre-optic ends, a danger warning as shown by the image below (or equivalent approved by the engineer), must be affixed to the panel, enclosure, etc. This label must comply with all the requirements stipulated in the JW Labelling Specification (Volume 25 of the Automation And Control Standards).



6.5 Cabling On Racks And Supports

6.5.1 Cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.

6.5.2 Cable ladders used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester). All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all these corrosive applications, and all exposed metal shall be painted with a 2-component auto-motive or industrial paint (2K poly urethane paint). Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin and painted with 2K paint to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should also be made from GRP. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.



6.5.3 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m^2, all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.

6.5.4 Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange.

6.5.5 Cable ladders used for all applications other than those mentioned in items 6.5.2 to 6.5.4 above shall be heavy-duty metal cable ladders, manufactured from corrosion resistant hot-dipped galvanised, powder coated, mild steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.

6.5.6 Power and control cabling must always be separated by no less than 500mm. Where it is unavoidable to cross power and control cabling, such cross-overs must be done at right angles.

6.5.7 Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs.

6.5.8 Bends in cable racks and supports shall have radii which will ensure that cables are not bent more than the safe criteria specified by the cable manufacturers. For this reason all racking, whether horizontal or vertical must include 90 degree bends where there are 90 degree direction changes in cable runs. I.e. cabling cannot be run from one straight cable rack onto another straight cable rack at 90 degrees, without a 90 degree cable rack bend.

6.5.9 Angle iron cable supports may be used. All such angle iron supports must be hot-dipped galvanised, 3CR12 grade stainless steel, 304 grade stainless steel or 316 grade stainless steel and electric orange powder coated as for the cable racks. The material will depend on the application area as specified in items 6.5.2 to 6.5.5 above.

6.5.10 No more than two cables may be run on a single angle iron support.

6.5.11 The size of angle iron supports must be such that no part of a cable projects beyond the support.

6.5.12 The minimum size of angle iron cable supports is 25mm x 25mm x 5mm.

6.5.13 Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris.

6.5.14 UV stabilised PVC straps may be used for cables up to 4core x 25mm^2. For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used.

6.5.15 Cables must be marked at both ends with stainless steel cable markers strapped to the cable with stainless steel or UV resistant straps in a position where this number is visible without the need to move cables or equipment to view the number. Cable numbering must comply with all the requirements of the Labelling Specification (Volume 25 of the Automation And Control Standards).

6.6 Electric Cable Terminations

6.6.1 All cable terminations must be made in a professional manner and cables shall be made off by using appropriate cable glands and UV treated shrouds. Glands similar or equal to the "Enviro" glands supplied by some manufacturers must be used. All cable glands must be:

- environmentally sealed to IP68 against the ingress of water from either end of the cable gland
- constructed from brass and black nylon plastic encapsulation
- supplied complete with brass locknut
- have a loose cone bush and cone ring
- suitable for use in an Ex e application and must therefore have an Ex identification band

6.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

6.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).






Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

6.6.4 Where lugs are bolted onto studs, suitably sized lugs must be used. Enlarged holes in lugs will not be accepted.

6.6.5 Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal

does not result in the loosening of the pin lug.

6.6.6 Where cable cores are terminated, sufficient slack must be allowed for wiring changes, re-terminations, etc.

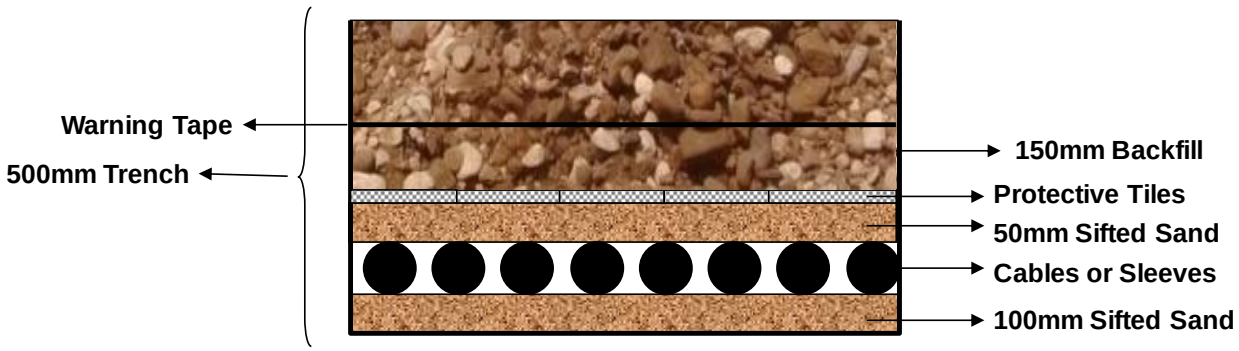
6.6.7 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

6.7 Cables, Sleeves Or Microduct Assemblies In Trenches

6.7.1 All cabling in trenches must be armoured cables to ensure sufficient mechanical protection.

6.7.2 Where cabling (electrical or fibre-optic) has to be done between points where cabling will not run along cable racks, in cable ducts or in cable tunnels, these cables or microduct assemblies for blown fibre must be run in trenches. Overhead cabling will not be acceptable. Blown fibre microduct assemblies buried in trenches must be suitable for direct burial.

6.7.3 Cable trenches must be at least 500 mm deep. There must be a 100mm layer of selective backfill (soft sifted sand), free of sharp and hard objects, at the bottom of the trench and another 50mm layer of selective backfill (soft sifted sand) directly above the cable, sleeves or microduct assemblies. Thereafter a single layer of protective pre-cast concrete tiles must be placed, without spaces between tiles, so that it forms one continuous protective layer. On top of the concrete tiles a layer of approximately150mm backfill must be placed before placing plastic cable warning tape. The warning tape must consist of a strip of polyethylene of thickness 0,04 mm and of nominal width 230 mm, completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091, and having printed at intervals not exceeding 1 metre along its length, a black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi". Thereafter the trench must be filled with sand (see the sketch below).



6.7.4 Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means.

The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

6.7.5 Where trenches pass under roads, railway lines, buildings, structures, etc., the cable trench must be at least 800 mm deep and at least 110mm HDPE (High-density polyethylene) double wall, corrugated pipes must be used as sleeving.

6.7.6 Protective concrete tiles in trenches under roads must comply with all the requirements listed in item 6.7.4 above plus the concrete tiles must not break if subjected to the heavy vehicle traffic on that road. The requirements mentioned in items 6.7.5 and 6.7.6 must be extended for 2 meters beyond the edge of roads to ensure that cables and cable sleeves will suffer no damage from heavy vehicles driving beyond the edge of the road.

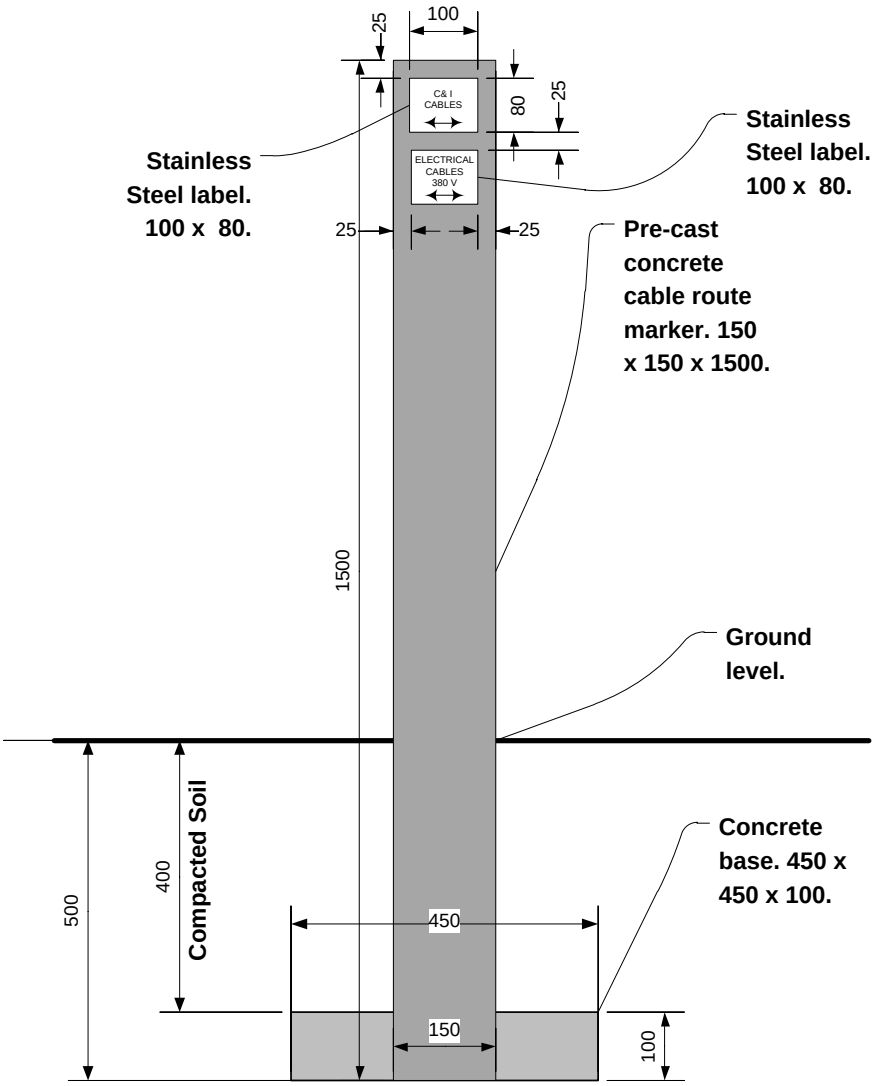
6.7.7 Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with “C&I CABLES” and/or “DATA CABLES” as applicable and the direction indicated in which the cables run. If there are electrical cables in the same trench, there must be a separate label engraved with “ELECTRICAL CABLES”, the voltage and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with “DATA CABLES” and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.

6.7.8 At the bottom of the post a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024:2006 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).

6.7.9 These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.

6.7.10 All route markers for C&I and data cables must be painted with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned with no more than 10% water to aid penetration. Thereafter reflective yellow paint, suitable for use on concrete, must be applied.

6.7.11 The diagram below provides the required detail of these cable route markers.



6.7.12 Power and control cables must remain separated by at least 500mm as stated earlier. This means that power and control cables are not to be installed in the same cable sleeve.

6.7.13 Where sleeves are used for cables, an accessible manhole must be installed on every 50m straight run of sleeve and at every change of direction. This manhole can be built from bricks or concrete or it can be polyethylene Stakboxes as shown in the example below. Lids used on Stakboxes must not be made of material that is prone to theft for scrap metal (such as mild, steel, cast iron, etc.



6.7.14 The manhole must be large enough to allow proper access for cable installation. For example a manhole on a straight length of sleeving must in any event also not be smaller than 300mm x 300mm. Manholes installed at a change of direction must be large enough so that the bending radius of any cable running through it is not smaller that the manufacturer's recommended bending radius. The manhole must also not be smaller than 300mm x 300mm. If the manhole is required to make cable splices (fibre or copper) it must comply with all the requirements of item 6.4.36 above and there must be enough space so that cable loops can be comfortably left in the manhole without exceeding manufacturer's recommended minimum bending radii. Such a manhole must in any event also not be smaller than 600mm x 600mm.

6.7.15 The larger the number of cables running through the manhole, the larger the manhole must be to ensure ease of cable installation.

6.7.16 The depth below ground level at which the cables run through the manhole must not be less that the required cable burial depth as specified in item 6.7.3 above.

6.7.17 All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.

6.7.18 Where manholes are installed in roads, paving or paths where vehicles can travel, the lids and lid support structure must be strong enough so that heavy vehicle traffic from that area will have no detrimental effect on the lid or manhole. Such manhole covers must not be manufactured from material such as cast iron which is prone to theft. Metal covers filled with concrete will be acceptable.

6.7.19 The manhole covers shall either have a latch that requires a special tool to unlock and remove, or be heavy enough that lifting equipment is required to remove them (see the picture below).



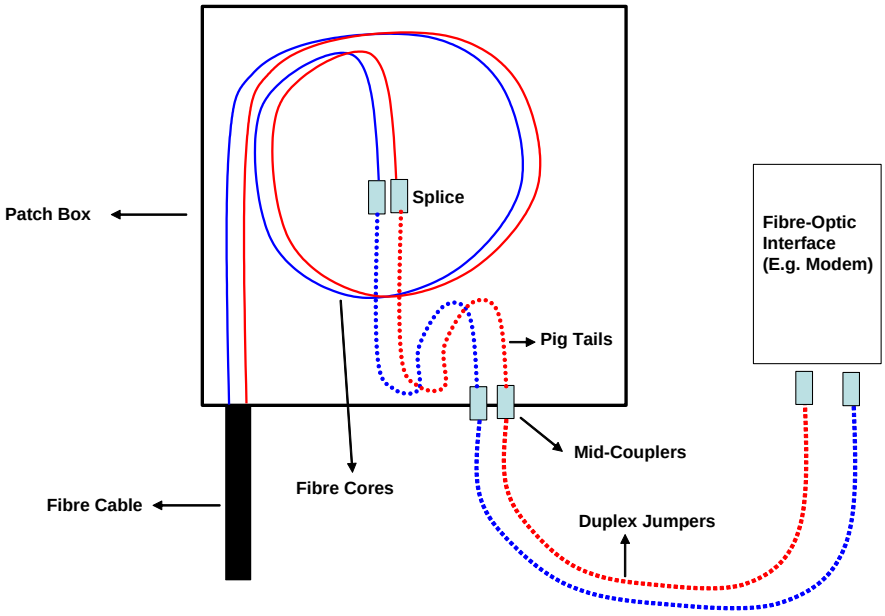
6.7.20 The base of the chamber must be made up of a dry mix of stone and cement so that it forms a hard but porous surface which is free draining for any water which enters the chamber.

6.7.21 All installed sleeves must be equipped with draw wires (or equivalent, such as nylon rope) to allow pulling in of cables. These draw wires must be non-corrosive and must be strong enough to pull the cables intended for that sleeve.

6.8 Fibre-Optic Data Cable Terminations

6.8.1 All terminations must be done by fusion splicing cores of the fibre-optic cable onto pre-fabricated “pig tails”, inside a “patch box”. The optical fibres will be terminated in the sequence specified in item 6.4.23 and 6.4.39 above.

6.8.2 The “patch box” must be equipped with mid-couplers, to accept the “pig tails” from inside the “patch box”. The other end of these mid-couplers must accept the ends of the duplex jumpers fitted with LC connectors at both ends, which in turn are connected to the fibre-optic interface (modem, switch, hub, etc.). This arrangement is to ensure that disconnecting for testing or maintenance purposes does not involve working where the splices were made (see the sketch below).



6.8.3 The “patch box” must be hardened and robust, with a minimum environmental rating of IP65 and suitable for use in industrial applications.

6.8.4 All splices must be fusion splices, and not mechanical splices.

6.8.5 All fibre-optic cables must be at least 12-core cables to ensure sufficient spare cores in the event of faults and for future modifications, additions, etc.

6.8.6 All fibre-optic data communication cables must be single mode.

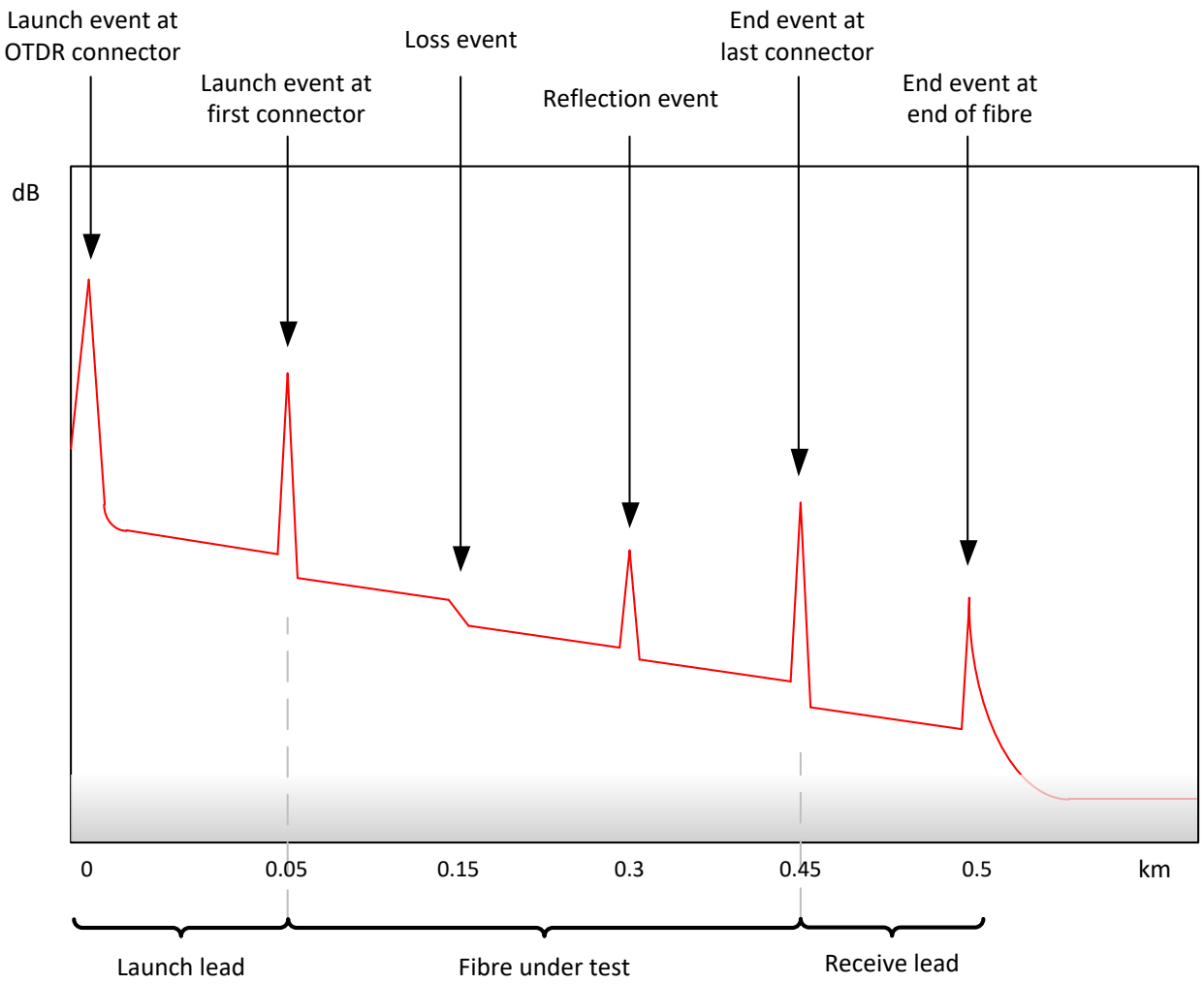
6.8.7 All fibre-optic cables supplied must comply with the relevant parts of SANS 60793/ IEC 60793 and SANS 60794/ IEC 60794 in terms of construction, installation and testing.

6.8.8 All the fibres and splices must be tested by an experienced fibre-optic network specialist and the results saved for analysis. The following tests have to be completed and test certificates have to be produced:

6.8.8.1 OTDR (optical time domain reflectometer) tests for all fibres at both 1310nm and 1550nm wavelengths, in both directions, must be completed when the cable is delivered to the site and again after the installation has been completed.

6.8.8.2 When performing OTDR tests, adequate launch and receiving leads must be used so that the splicing on both ends of the cable is clearly visible on the OTDR trace. The pulse width must be set to the minimum possible width for the distance under test and the time duration of the test must not be less than sixty (60) seconds. The scale of the trace should be set to 1.5x to 2x the length of the cable under test. The measured loss of each event must be captured in MS Excel and the original OTDR results must be saved in its native format. The results must be supplied to the engineer for approval. A typical OTDR trace is shown below.

Typical OTDR trace

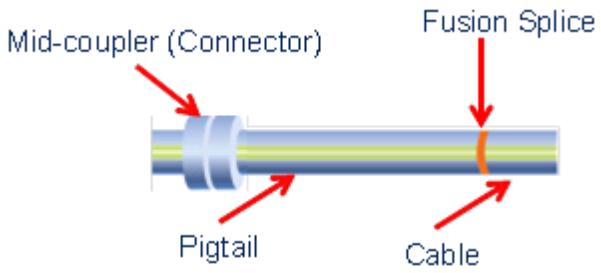


6.8.8.3 OLTS (optical loss test set) analysis with a power source and power meter must be done for all fibres after the installation has been completed. These tests must be done in both directions and the results have to be captured in MS Excel. A typical test report for one fibre is shown below. (P/Loss = Power Loss; ORL = Optical Reflection Loss).

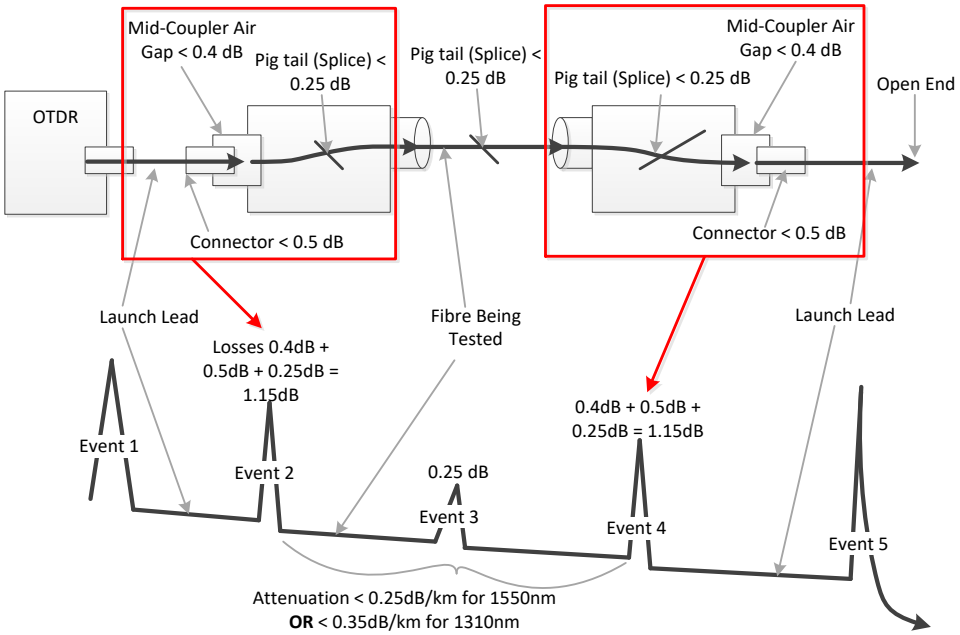
Fibre ID	Wavelength	P/Loss	P/Loss	Average	ORL A	ORL B	Length
		A->B	**B->A**				
	(nm)	(dB)	(dB)	(dB)	(dB)	(dB)	(km)

6.8.9 Losses in any fibre-optic core measured end-to-end at wavelengths of 1310nm and 1550nm, must not exceed **0.25dB per fusion splice**. The attenuation over the length of the fibre must not exceed 0.35dB/km at 1310nm and 0.25dB/km at 1550nm.

6.8.10 Losses over any connection (i.e. including mid-couplers) must not exceed 0.5dB.



6.8.11 The figure above shows a typical patch box situation (see item 6.8.2) where a pigtail is spliced onto the cable at one end and onto a connector (the mid-coupler) at the other end. These two events are too close together to be identified as separate events by an OTDR test. The overall maximum acceptable loss (at 1310 nm or 1550nm) for this combination will thus be **0.5 (connection) + 0.25 (fusion splice) = 0.75 dB**. This requirement is illustrated in the sketch below.



6.8.12 SFP's should be used so that the length of a fibre measured from one end to the other is greater than 5% of the rated maximum distance specified by the manufacturer of the SFP.

6.9 Copper Data Cables

6.9.1 All copper data cable shall be a high performance, 4-pair, Category 6, 23 AWG, unshielded, twisted pair (U/UTP) with solid copper conductors, polyolefin insulated PVC or low-flammability sheath and colour-coded pairs.

6.9.2 All copper data cable shall be tested after installation using an instrument with the capability of certifying the cable as Category 6 as specified in the TIA/EIA 568-B.2-10 industry standard.

6.10 Data Cabling General

6.10.1 All data cabling systems must be designed and installed in accordance with ISO/IEC SANS 11801:2002.

6.10.2 The cables must comply with EN 50288-5/6.

6.10.3 In terms of flammability, the cables or blown fibre microduct assemblies inside buildings (whether on racks, in ceilings, under floor panels, etc.) must comply with IEC 60332-1.

6.11 Cable Theft Prevention Measures

6.11.1 Cable theft prevention methods must be discussed with each site manager and implemented to suit the unique requirements in each area on each site.

6.11.2 Trenches in high risk areas (as defined by the relevant site manager) will have a 100mm thick layer of 20/20 concrete (i.e. 20MPA strength and 20mm aggregate size) supplied in the place of the concrete tiles.

6.11.3 Where inverted culverts with cable racking inside the culverts and concrete covers over the culverts are used the concrete covers must be constructed of reinforced concrete. The slabs must be sized to suit the width of the culvert. Each slab must weigh at least 100kg and must be provided with only two lifting holes.

6.11.4 Where cables are laid in trenches, the contractor must ensure that cable de-rating factors are strictly applied in accordance with SANS 10142-1:2003 to prevent cables from overheating. This clause is especially important to adhere to when existing inverted culverts with existing installed cables are to be filled with soil.

6.11.5 No bare copper conductors are to be used for earth conductors, earth strapping, earth bonding, etc. If possible a 5-core cable should be used to allow the 5^{th} core to be used as an earth conductor. If this is not a viable option, a 2-core PVC, SWA cable must be installed as an earth cable.

6.11.6 For short runs of earth cable (such as bonding of earth bars or earthing conductors of buildings), other cable (i.e. not copper), approved by the Engineer, must be used.

6.11.7 For high risk areas where cable racking is used, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers.

6.11.8 If any additional cable theft prevention methods are required, such requirements will be made clear to the contractor at the time of tender.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 7 : NETWORKING

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 7 : Networking**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 7**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	15	C. Du Toit	Cover page updated
2019-06-25	14	C. Du Toit	Revision approved by JW.
2018-11-30	13	C. Du Toit	Added reference to Labelling specification.
2014-04-17	12	C. Du Toit	Added use of blown fibre.
2013-10-07	11	C. Du Toit	Updated footer.
2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC), updated core switch port requirements, core switch power supply requirements,
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Area and core switch requirements clarified, data irrelevant to tenderers deleted and data sheets
2010-03-12	6	C. Du Toit	Fibre core switch requirements updated to specify Gigabit uplinks and to include a data sheet.

2009-08-18	5	C. Du Toit	New logos added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2009-02-24	3	C. Du Toit	Switch requirements from specialist added plus "Joburg" & "JW" Logos added to top & partnership
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

7 NETWORKING 4

7.1 Scope 4

7.2 Abbreviations 4

7.3 Standards 5

7.4 Communication Protocol 5

7.5 Network Topology 6

7.6 Switches 7

7.7 Compliance With Standards 9

7.8 Network Switch Data Sheets 9

7.9 Redundancy Testing 9

7.10 Labelling 10

7 NETWORKING

7.1 Scope

7.1.1 This specification covers the supply and installation of equipment, the network topologies, the communication methods and the security for data communication systems, typically between Programmable Logic Controllers and Supervisory systems, used in process monitoring and control applications at Johannesburg Water wastewater sites.

7.2 Abbreviations

7.2.1 In this specification the following abbreviations will apply :-

CD	:	Compact Disk
CLI	:	Command Line Interface
DiffServ	:	Differentiated Services
EMC	:	Electro-Magnetic Compatibility
GARP	:	Generic Attribute Registration Protocol
GMRP	:	GARP Multicast Registration Protocol
GUI	:	Graphical User Interface
GVRP	:	GARP VLAN Registration Protocol
HTTPS	:	Hyper Text Transfer Protocol Secure switches
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers
IGMP	:	Internet Group Management Protocol
LACP	:	Link Aggregation Control Protocol
LAN	:	Local Area Network
LED	:	Light Emitting Diode
MAC	:	Media Access Control
Mbit	:	Mega bits
Mbps	:	Mega bits per second
MDI/MDI-X	:	Medium Dependent Interface/ Medium Dependent Interface (crossed)
OS	:	Operating system
PC	:	Personal Computer
PLC	:	Programmable Logic Controller
QoS	:	Quality Of Service
RD	:	Read
RSTP	:	Rapid Spanning Tree Protocol
SANS	:	South African National Standards
SCADA	:	Supervisory Control And Data Acquisition

SNMP	:	Simple Network Management Protocol
SSH	:	Secure Shell
SSL	:	Secure Sockets Layer
TCP/IP	:	Transmission Collision Protocol/Internet Protocol
TOS	:	Type Of Service
TX	:	Transmit
USB	:	Universal Serial Bus
VLAN	:	Virtual Local Area Network

7.3 Standards

7.3.1 All design standards shall be subject to the latest amendments and editions of the following standard specifications:-

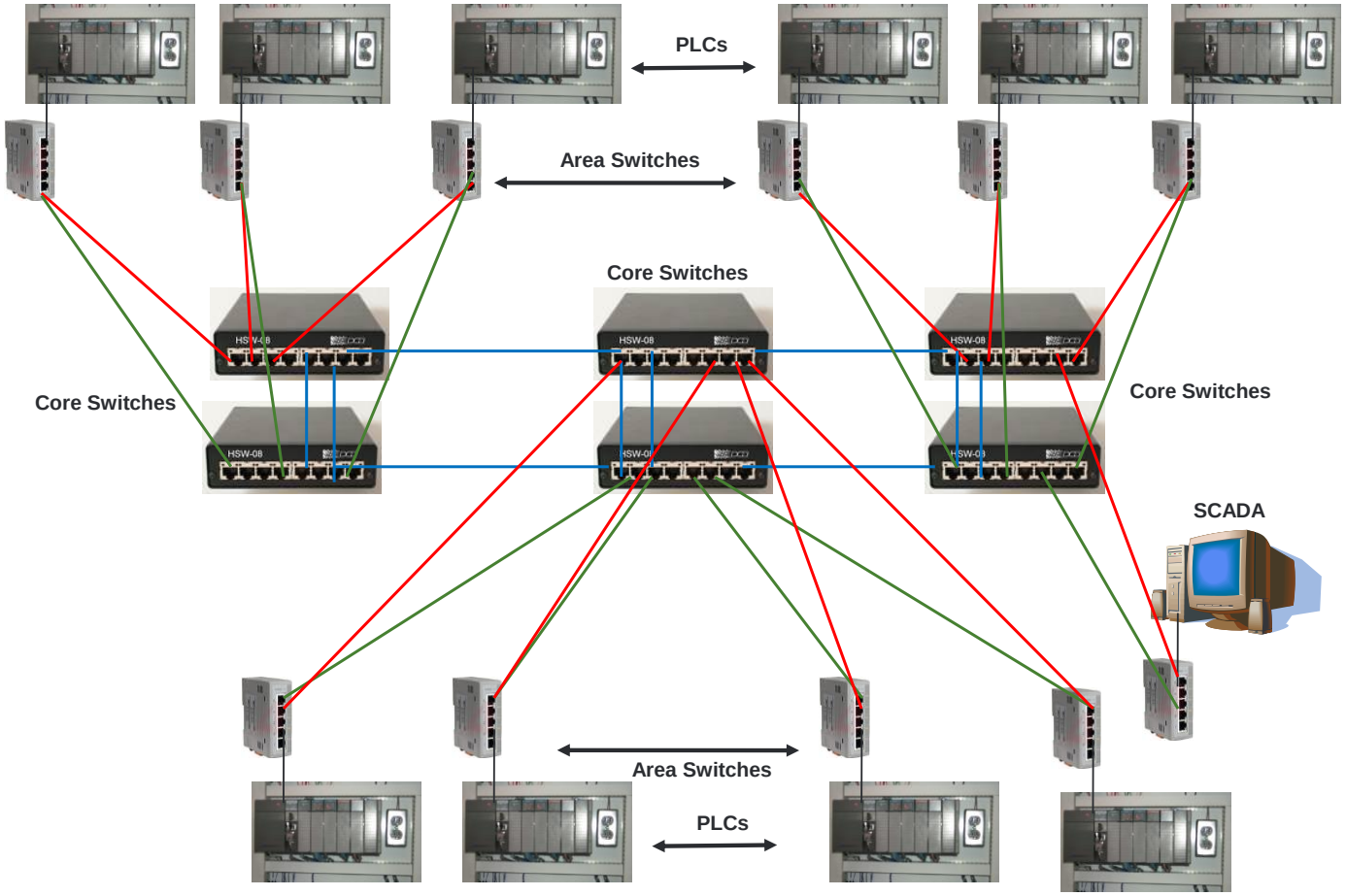
SANS 10142-1	:	National Standards for the wiring of premises
IEEE 802.3-2005	:	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications
IEEE 802.3ad (Now IEEE 802.1AX)	:	Link Aggregation
IEEE 802.1d	:	MAC Bridges
IEEE 802.1p	:	Quality of service
IEEE 802.1Q	:	VLAN Tagging
IEEE 802.1w	:	Rapid Spanning Tree Protocol
IEEE 802.1X	:	Port Based Network Access Control
IEC 60068-2-6	:	Environmental Testing - Vibration
IEC 60068-2-27	:	Environmental Testing – Test Ea and guidance: Shock
SANS 61000-4/IEC 61000-4	:	Electromagnetic compatibility – testing and measurement techniques

7.4 Communication Protocol

7.4.1 The preferred method of communication between PLC’s or between PLC’s and SCADA systems is Ethernet TCP/IP.

7.4.2 Systems must be designed and equipment selected with the view of communicating via TCP/IP over Ethernet.

7.5 Network Topology



7.5.1 The preferred topology is an Ethernet star/mesh topology as indicated in the diagram above.

7.5.2 Where existing installations make the use of a star/mesh topology impractical, contractors must link into the existing system in such a way that future conversion to a star/mesh topology will not be hampered by the current installation.

7.5.3 All systems must be designed and equipment selected with the view of converting to a star/mesh topology when possible.

7.5.4 Network redundancy must be such that if one core switch fails, there must be a second one that can maintain communication (as shown in the diagram above).

7.5.5 Data communication between core switches and from core switches to the area switch patch panels must be done via 9/125µm, single mode, PVC, CST (Corrugated Steel Tape) cable or single mode blown fibre microduct assemblies (see the Cabling Specification (Volume 6 of the Automation And Control Standards)). The number of cores must be as specified in the project scope of work and the tender bill of quantities.

7.5.6 Each core switch pair (i.e. the two core switches which form a dual redundant system at a particular location) must be equipped with two UPSs (Uninterruptable Power Supplies) as specified in the “Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection”. The two power supplies must be connected to both switches (i.e. each UPS supplies both core switches) to provide redundancy. These supplies must also be equipped with proper surge protection as detailed in the same specification - “Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection”.

7.6 Switches

7.6.1 Minimum Requirements For Area Switches

7.6.1.1 Only industrial type switches will be accepted. No standard “commercial” or “Office” switches will be accepted. These switches must have at least an IP 20 rating, must have a rugged high-strength metal case and must have DIN-rail or panel mounting ability. They must have an operating temperature of at least 0 to 55ºC, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.

7.6.1.2 Redundancy and fault recovery:

- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol

7.6.1.3 Remote management and monitoring:

- Must support SNMP V1/V2/V3 for different levels of network management security

7.6.1.4 Area switches must have at least two SFP uplink ports which are 1000Base-LX Gigabit Ethernet standard compatible. These ports must be compatible with Duplex LC-type connectors for single-mode fibre.

7.6.1.5 Area switches must have the number of copper ports as specified in the project scope of work and the tender bill of quantities. The copper ports must be 10BASE-T/100BASE-TX compatible in order to communicate with the PLCs. These ports must be capable of accepting RJ45 connectors on CAT-6 cable.

7.6.1.6 In terms of configuration, maintenance, management and monitoring features required, all area switches must:

- Have support for loading or saving configurations to a remote host
- Have port monitoring for debugging
- Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
- Be configurable by Operating System (OS) independent web browser, using secure HTTPS

7.6.2 Minimum Requirements For Core Switches

7.6.2.1 Only industrial type switches will be accepted. No standard “commercial” or “Office” switches will be accepted. These switches

must have redundant, dual DC power units, must have at least an IP 30 rating, must have a rugged high-strength metal case and must be 19" rack-mounted switches. They must have an operating temperature of at least 0 to 55ºC, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.

7.6.2.2 Redundancy and fault recovery:

- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol
- Must comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking and must have at least 4 trunks.

7.6.2.3 Broadcast isolation and network segmentation:

- Must comply with IEEE 802.1Q in terms of support for VLAN Registration Protocol (GVRP) to ease network planning

7.6.2.4 Quality of service:

- Must comply with IEEE 802.1p/1Q in terms of support for TOS/DiffServ in order to increase determinism

7.6.2.5 Multicasting:

- Must have IGMP Snooping and GMRP for filtering multicast traffic from industrial Ethernet protocols

7.6.2.6 Security and authentication:

- Must comply with IEEE 802.1X in terms of support for SSL to enhance network security

7.6.2.7 Remote management and monitoring:

- Must support SNMP V1/V2/V3 for different levels of network management security

7.6.2.8 Core switches must be managed, Layer 3 switches with the number of ports as specified in the project scope of work and the tender bill of quantities.

7.6.2.9 Core switches must provide support for a minimum of four trunked Gigabit SFP ports with 1000Base-LC, LC connectors.

7.6.2.10 Core switches must provide support for a minimum of eight SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX,) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX).

7.6.2.11 In terms of configuration, maintenance, management and monitoring features required, all core switches must:

- Have support for loading or saving configurations to a remote host
- Have port monitoring for debugging
- Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
- Be configurable by Operating System (OS) independent web browser, using secure HTTPS
- Be configurable by CLI by Local Serial console and remote SSH network connection
- Support ping commands to identify network segment integrity

7.7 Compliance With Standards

7.7.1 It is important that all equipment is selected and installations are done to industrial standards. These are usually harsh environments in terms of dirt, industrial activities such as welding, grinding, etc. and electrical interference such as lightning, capacitor switching, large drives starting and stopping, etc.

7.7.2 The complete installation and networking system must comply with IEEE 802.3-2005.

7.7.3 The equipment installed must comply with SANS 61000-4/IEC 61000-4 for EMC.

7.7.4 The equipment installed must comply with IEC 60068-2-6 for vibration (10 to 57 Hz – amplitude 0.15mm, 57 to 150 Hz – acceleration 2g).

7.7.5 The equipment installed must comply with IEC 60068-2-27 for shock (12 shocks semi-sinusoidal, 15g, 11ms).

7.7.6 All installations must comply with the requirements of SANS 10142-1.

7.8 Network Switch Data Sheets

7.8.1 For network switches supplied, the tenderer must supply the data sheets shown in Appendix A with his tender.

7.8.2 All installations must comply with the requirements of SANS 10142-1.

7.9 Redundancy Testing

7.9.1 All the core network switches and area switches that have been installed in a redundant configuration must to be tested by a network specialist and the results documented. The contractor must make the following equipment available to complete these tests:

- Two portable area switches as specified in 7.6.1
- Two portable computers, running from a CD ROM-booted operating system (e.g. Linux LiveCD)

7.9.2 The following ping test procedures must be followed using ICMP (Internet Control Message Protocol).

- Continuous ping messages will be sent form a portable test computer located at the core switch to a remote portable test computer that will be moved around all the network points (i.e. the area switches) to confirm the data throughput, latency (ping time) and network failover time.
- Confirm that the round-trip ping times with a packet size of 10kb does not exceed 2 milliseconds.
- Confirm that the continuous ping messages recovers within 3 seconds after either one of the redundant core switches has been powered down or powered up and after either one of the fly leads to the area switch has been disconnected form a core switch.
- Capture the result as indicated in the following example:

Port No	PING Time	SW0-A Switch Down	SW0-B Switch Down	SW0-A Link Down	SW0-B Link Down	Comments
1	<1ms	✓	✓	✓	✓	Location L2

7.10 Labelling

7.10.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

APPENDIX 1

DATA SHEET - FIBRE "CORE" GIGABIT ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
19" Rack-mount switch?	☐ Yes ☐ No
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
Comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking?	☐ Yes ☐ No
Switch has at least 4 trunks?	☐ Yes ☐ No
Comply with IEEE 802.1Q i.t.o. support for VLAN Registration Protocol (GVRP)?	☐ Yes ☐ No
Comply with IEEE 802.1p/1Q i.t.o. support for TOS/DiffServ?	☐ Yes ☐ No
Comply with IEEE 802.1X i.t.o. support for SSL?	☐ Yes ☐ No
Support SNMP V1/V2/V3 for different levels of network management security?	☐ Yes ☐ No
Is it a managed, Layer 3 switch?	☐ Yes ☐ No
At least 8 SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX)?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Configurable by CLI by Local Serial console and remote SSH?	☐ Yes ☐ No
Support ping commands to identify network segment integrity?	☐ Yes ☐ No

Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

DATA SHEET – "AREA" ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
SFP Uplink ports which are 1000BASE-LX Gigabit Ethernet standard compatible?	☐ Yes ☐ No
Uplink ports compatible with Duplex LC-type connectors for single-mode fibre?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 8 : FLOW MEASUREMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 18 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 8 : Flow Measurement**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 8**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	18	C. Du Toit	Cover page updated
2019-06-15	17	C. Du Toit	Added electronic calibration data storage requirement.
2018-11-30	16	C. Du Toit	Changed from annubar to thermal dispersion gas flow measurement.
2018-11-30	15	C. Du Toit	Added reference to Labelling specification and made allowance for new area/velocity flow measurement.
2014-04-17	14	C. Du Toit	Added reference to FJB specification.
2013-10-07	13	C. Du Toit	Updated footer, updated mag flow meter requirements & added area-velocity flow meters
2012-07-27	12	C. Du Toit	Updated headers & footers.
2012-03-08	11	C. Du Toit	Corrected accuracy requirements for electromagnetic flow meters.
2012-03-08	10	C. Du Toit	Altered gas flow to use orifice plate or pitot tube and changed (Pty) to (SOC).
2011-07-11	9	C. Du Toit	Removed 2010 logo.
2010-07-27	8	C. Du Toit	Gas flow meter ambient temperature range altered and data about classification of IS designs and installations

2009-08-18	7	C. Du Toit	New logos and transmitter position requirements added and mag flow pulse output requirements altered.
2009-05-08	6	C. Du Toit	Added requirements from client meeting on 04 May 2009.
2009-03-25	5	C. Du Toit	JW Wastewater Partnership deleted, logos altered as per client's requirements and data sheets for magnetic
2007-11-07	4	C. Du Toit	Flow meters for distributing/flow diversion added.
2007-09-10	3	C. Du Toit	Gas flow measurement added and "Minimum" 500 ohm load changed to "Maximum".
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

8 FLOW MEASUREMENT 4

8.1 Scope 4

8.2 Abbreviations 4

8.3 Standards 5

8.4 General Requirements 5

8.5 Surge Protection 7

8.6 Open Channel Flow Measurement – Controller/Transmitter 7

8.7 Open Channel Flow Measurement – Sensor/Transducer 8

8.8 Full Pipeline Flow Measurement – Controller/Transmitter 8

8.9 Full Pipeline Flow Measurement – Sensor/Transducer 9

8.10 Partially Filled Pipeline Or Channel Flow Measurement – Controller/Transmitter 10

8.11 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Velocity Measurement 10

8.12 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Level Measurement 11

8.13 Partially Filled Pipeline Flow Measurement – General 11

8.14 Gas Flow 11

8.15 Spares 12

8.16 Hazardous Areas 12

8.17 Intrinsically Safe Installations 13

8.18 Data Sheets 13

8 FLOW MEASUREMENT

8.1 Scope

8.1.1 This specification covers the supply and installation of Flow meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

8.2 Abbreviations

8.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
PTFE	:	Polytetrafluoroethylene
O&M	:	Operating And Maintenance

NPT	:	National Pipe Thread
DP	:	Differential Pressure
LP	:	Low Pressure
HP	:	High Pressure
RH	:	Relative Humidity
IS	:	Intrinsically Safe

8.3 Standards

8.3.1 The supply and installation of all Flow meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.
BS 3680	:	Measurement of liquid flow in open channels.
SANS10108:2005	:	The classification of hazardous locations and the selection of apparatus for use in such locations.
SANS60079-10:2005	:	Electrical apparatus for explosive gas atmospheres. Part 10: Classification of hazardous areas.
SANS60079-11:2005	:	Electrical apparatus for explosive gas atmospheres. Part 10: Intrinsic safety “i”.
SANS10086-1	:	The installation, inspection and maintenance of equipment used in explosive atmospheres Part 1: Installations including surface installations on mines

8.4 General Requirements

8.4.1 This specification must be read in conjunction with the following specifications:-

8.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

8.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

8.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

8.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

8.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

8.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

8.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

8.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

8.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. LCD displays must always be protected from direct sunlight, either by facing them away from the sun or by installing it inside the FJB, in the shade of the FJB canopy. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

8.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

8.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

8.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or

replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

8.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

8.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

8.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

8.4.13 If a flow meter (for any application) is offered, which has the facility to store calibration and set-up data electronically, so that it can be downloaded when an instrument is replaced, the contractor must include the supply of all the necessary equipment (special cables, memory cards, etc.) to enable the use of this facility.

8.4.14 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

8.5 Surge Protection

8.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.6 Open Channel Flow Measurement – Controller/Transmitter

8.6.1 Flow calculations for all open channel flow measurement must be done in accordance with BS 3680.

8.6.2 All flow measurements in open channels must be done by using ultra-sonic distance measurement, which is converted into a flow value at weirs or venturi flumes. Where there are no weirs or venturi flumes, area/velocity flow meters must be used (see requirements later in this specification).

8.6.3 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

8.6.4 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

8.6.5 The instrument must be equipped with at least one SPDT relay, rated for at least 230V AC, 500mA, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.

8.6.6 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

8.6.7 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.

8.6.8 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.

8.6.9 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.7 Open Channel Flow Measurement – Sensor/Transducer

8.7.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).

8.7.2 The sensor must be suitable for an operating temperature range of -10ºC to +50ºC.

8.7.3 The sensor must be equipped with automatic temperature compensation.

8.7.4 The sensor must have a protection rating of at least IP 67 or higher.

8.7.5 Brackets used for the mounting of ultra-sonic sensor heads and velocity sensor heads (if external velocity sensors are used) must be made of at least 3CR12 grade stainless steel.

8.8 Full Pipeline Flow Measurement – Controller/Transmitter

8.8.1 All flow measurements in full pipelines must be done by using electro-magnetic flow (mag-flow) measurement, which is converted into a flow value where accuracy of measurement is required for dosing and/or custody transfer of flow. Where measurement for flow distribution or flow diversion is required or for pump protection (i.e. where high accuracy is not essential), non-intrusive flow measurement using external sensors can be applied. These systems must incorporate either ultrasonic time of flight or Doppler principles. Ultrasonic time of flight systems can be used on clean water with low contents of air bubbles or other entrained gasses and suspended solids of less than 10,000 milligrams/litre. Doppler systems can be used on liquids with entrained particles or gasses of 100 microns or larger and suspended solids in excess of 75 milligrams/litre.

8.8.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

8.8.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

8.8.4 The instrument must be equipped with at least one SPDT relay, or an output that can be used to drive a relay, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.

8.8.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

8.8.6 The transmitter for electro-magnetic flow meters must have an accuracy of at least 0.5%, or better, of the measured value for flow velocities which are greater than 0.5 meters/second. Transmitters of flow meters for flow distribution/diversion can have an accuracy of less than 0.5% but they must not be less accurate than ±2% of the full scale for Doppler meters and not less than ±2% of the measured value for time of flight meters. For both Doppler and time of flight meters these accuracy requirements apply to flow velocities of 0.5 meters/second or greater. Repeatability must not be less than 1% of the measured value.

8.8.7 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.9 Full Pipeline Flow Measurement – Sensor/Transducer

8.9.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).

8.9.2 The sensor lining for electro-magnetic flow meters used in sludge or non-corrosive liquids must be Neoprene or Rubber, suitable for operating in temperatures ranging from -10ºC to +80ºC.

8.9.3 The sensor lining for electro-magnetic flow meters used in corrosive or heated liquids must be PTFE, suitable for operating in temperatures ranging from -20ºC to +150ºC.

8.9.4 The sensor must have a protection rating of at least IP 68 or higher.

8.9.5 The sensor tube material for electro-magnetic flow meters must be at least 304, 316 or 3CR12 grade stainless steel.

8.9.6 The sensor electrode material for electromagnetic flow meters must be at least 304, 316 or Hastelloy C grade stainless steel.

8.9.7 The sensor for electromagnetic flow meters must have either a grounding electrode or earth rings fitted.

8.9.8 Where process flow in the pipeline cannot be stopped or isolated by any other means, isolation hand valves must be fitted on either side of electro-magnetic flow meters for removal/replacement of the flow meter.

8.9.9 The sensor material for flow meters used for flow distribution/diversion must be stainless steel.

8.9.10 Magnetic flow meters must be equipped with an “Empty Pipe” detection which is configurable to stop the 4-20mA flow indication and/or operate a potential free contact, or an output that can be used to drive a relay, for PLC interfacing.

8.9.11 Electro-magnetic flow meters must not be a wafer-type. I.e. the sensor tube or wafer must be housed in a flanged stainless steel spool piece which can readily be bolted onto flanges in the pipe where it must be installed.

8.10 Partially Filled Pipeline Or Channel Flow Measurement – Controller/Transmitter

8.10.1 Where electro-magnetic flow meters (e.g. for full pipes) or conventional ultrasonic flow meters (e.g. at weirs or venturi flumes) cannot be used, such as in partially filled pipes or open channels without a weir or venturi, area-velocity flow meters must be used. A liquid velocity measurement as well as a liquid depth measurement, together with the dimension of the pipe or channel which is programmed into the controller/transmitter, must then be used to produce a proportional flow measurement.

8.10.2 The flow measurement must be done by using ultrasonic, microwave or radar signals to measure both velocity and depth of liquid.

8.10.3 The controller/transmitter must have at least an IP66 rating or higher.

8.10.4 The controller/transmitter must have a backlit LCD display to display flow rate and total flow.

8.10.5 The error of the level measurement must not be more than 0.25% of the range and the error of the velocity must not exceed 2% of the velocity reading.

8.10.6 The repeatability and linearity must be 0.1% or better.

8.10.7 The unit must be suitable for use with a 230V AC supply.

8.10.8 The unit must have 3 x 4-20mA outputs, one for flow, one for level and one for velocity.

8.10.9 The unit must have at least 2 x SPDT relays, rated at no less than 2A at 230V AC. One of the relays must be programmable for flow pulses and the other must be programmable for flow and/or level alarm.

8.10.10 The unit must have at least 3 x 4-20mA outputs, one for velocity, one for level/depth and one for flow. These outputs will be connected to a maximum 500 ohm load.

8.10.11 The unit must suitable for operating in temperatures ranging from minus 15ºC to +60ºC.

8.11 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Velocity Measurement

8.11.1 If the velocity sensor is installed below the water, the velocity sensor must be shaped and installed in such a manner that the cabling to it is protected from any debris that might flow in that pipe or channel.

8.11.2 The velocity sensor must be able to measure in a range of 0.03 to 6.2 m/sec and reverse flow of -1.5m/sec if a submerged sensor is used. If an non-submerged sensor is used, it must be able to measure in a range of 0.2 to 6 m/sec.

8.11.3 The velocity sensor must be suitable for operating in temperatures ranging from minus 15ºC to +65ºC.

8.11.4 The velocity sensor must be equipped with continuous, automatic temperature compensation.

8.12 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Level Measurement

8.12.1 The level sensor must have a low profile, in order to provide the maximum measuring distance in enclosed pipes.

8.12.2 The level sensor must have a measuring range of at least 3.66m and a minimum range (deadband) of not more than 203.2mm.

8.12.3 The level sensor must be suitable for operating in temperatures ranging from minus 15ºC to +65ºC.

8.12.4 The level sensor must be equipped with continuous, automatic temperature compensation.

8.13 Partially Filled Pipeline Flow Measurement – General

8.13.1 The submerged velocity sensor must not be installed in locations where sediment builds up.

8.13.2 The sensors must not be installed in locations where there is high water turbulence (the lower the turbulence, the higher the accuracy).

8.13.3 The sensors must be installed in locations where the velocity and level are equally distributed across the channel or pipe.

8.13.4 The channel or pipe where the sensors are installed must not have drops or direction changes immediately upstream of the sensors.

8.13.5 The slope of the pipe or channel where the sensors are installed must not exceed 3%.

8.13.6 Under no circumstances must sensors be installed in a manner or in a location which makes it impossible for site maintenance staff to access it for repairs or replacement later.

8.14 Gas Flow

8.14.1 The flow measurement must be done by using thermal dispersion technology, with a guaranteed drift-free operation and a turn down ratio up to 100:1 to measure volumetric gas flow. With thermal dispersion, two temperature probes are used. The first probe generates a temperature and the second one measures the dispersed temperature. Thermal dispersion measurement must be unaffected by changes in gas pressure or gas temperature. The sensor must also maintain a minimum accuracy of 2% of the reading ± 0.2% of full scale for changes in gas composition as high as ±2.5% of CH_4.

8.14.2 The instrument must be equipped with a remote transmitter which can be mounted in an IJB located in an easily accessible location in a non-hazardous area for viewing, maintenance and repairs. The transmitter shall have a 10-digit LED display for indication of flow rate and totalised flow. Where compensating leads for Pt100s are used, the contractor must ensure that the cable between the sensor

and transmitter is installed as supplied by the supplier. I.e. cables must not be cut. Excess cable must be coiled up neatly at the IJB.

8.14.3 The instrument must be equipped with integrated compensation for humidity. The average biogas composition which will be used must be 60% Methane and 40% Carbon Dioxide.

8.14.4 All instrument transmitter enclosures must have at least an IP 67 or higher rating.

8.14.5 The instrument must be equipped with a 4 – 20mA output which will be connected to a maximum 500 ohm load, for instantaneous volumetric flow in m^3/hr. It must also be equipped with a pulsed output for flow totalization.

8.14.6 The instrument must be suitable for use with a 24V DC power supply and it must have an EEx [i, e or d] rating, suitable for use in a Zone 1 area with Methane gas.

8.14.7 The sensor shall be of the insertion type with full stainless steel design. The housing shall be a compression-proof, dual compartment, stainless steel housing of material type DIN 1.4571 (316Ti). All sealing on the housing shall be done with Viton “O” rings.

8.14.8 The sensor must be equipped with a hot tapping unit for ease of insertion removal during normal digester operation. The compression fitting on the hot tapping unit must be with a metal-Viton elastomer design, resistant to pipe vibration and with a robust, threaded process connection for frequent mounting/dismounting of the sensor for inspection.

8.14.9 The sensor must be installed strictly in accordance with the supplier’s recommendations and requirements. The sensor must be equipped with locating pins to ensure that the sensor cannot be replaced incorrectly after removal.

8.14.10 The range of the instrument must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification)

8.14.11 The instrument must be suitable for an ambient operating temperature range of minus 20ºC to +70ºC and a process temperature operating range of minus20ºC to +120ºC.

8.14.12 The instrument must be suitable for operating in a humidity range of 0 to 100% RH.

8.15 Spares

8.15.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

8.16 Hazardous Areas

8.16.1 If the flow meter is going to be used for any combustible gas flow measurement, the tenderer must ensure that there is a hazardous area classification for the area in which the instrument will be installed.

8.16.2 If no hazardous area classification exists, the tenderer must allow a suitable cost for the classification of all relevant areas and must clearly indicate this cost in either the Bill Of Quantities or in a covering letter.

8.16.3 The flow meter and associated equipment supplied must all be suitable for use in the hazardous area concerned.

8.17 Intrinsically Safe Installations

8.17.1 Where intrinsically safe (IS) installations are required the tenderer must allow a cost to have the IS design from the Engineer certified as safe and compliant with the relevant legal requirements. This certification can only be done by a suitably accredited organization or company.

8.17.2 Once the certified IS design has been installed, the installation must be certified as correct and in accordance with the certified design. The tenderer must allow a cost for the certification. This certification can only be done by a suitably accredited organization or company.

8.17.3 All instruments supplied for use in a hazardous area must have the hazardous area rating and classification (E.g. Ex ia IIC T5) and suitable marking as specified in SANS 10108, ARP 0108:2007, Annex B, indicated on the instrument and the instrument must be certified by an approved testing/certification body as listed in SANS 0108, ARP 0108:2007.

8.18 Data Sheets

8.18.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – OPEN CHANNEL FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER (MAGNETIC)

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A or 24V DC output) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor wafer-type or flange-type?	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Transducer/Sensor lining material	
Transducer/Sensor tube material	
Transducer/Sensor grounding details	
Transducer/Sensor equipped with “Empty Pipe” detection as specified (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER FOR DISTRIBUTION/DIVERSION

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor material	
Transducer/Sensor rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – GAS FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output	
Hazardous area rating (E.G. Ex ia IIC T5)	
Hazardous classification certification body (E.G. CSA, CESI, DEMKO, DMT, LCIE, etc.) as approved by SANS 10108, ARP 0108:2007.	
Controller/Transmitter Enclosure Rating	
Accuracy	
Range	
Display Data & Type (E.g. instantaneous m^3/hr LCD)	
Ambient temperature operating range	
Process temperature operating range	
Humidity range	
Sensor material	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – AREA-VELOCITY FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
No. Of Analogue Outputs	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 2A) & Programmable (Y/N)?	
No. Of Relay Outputs	
Controller/Transmitter Enclosure Rating	
Velocity Accuracy	
Level Accuracy	
Repeatability & Linearity	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Velocity Transducer/Sensor range	
Level Transducer/Sensor range	
Velocity Transducer/Sensor temperature operating range	
Level Transducer/Sensor temperature operating range	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 9 : LEVEL MEASUREMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 14 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 9 : Level Measurement**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 9**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	04/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
2019-06-25	13	C. Du Toit	Revision approved by JW.
2018-11-30	12	C. Du Toit	Added reference to Labelling specification.
2014-04-17	11	C. Du Toit	Added reference to FJB specification.
2013-10-07	10	C. Du Toit	Updated footer
2012-07-27	9	C. Du Toit	Updated headers & footers.
2012-03-08	8	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	7	C. Du Toit	Removed 2010 logo.
2010-07-27	6	C. Du Toit	Transmitter relay rating altered.
2009-08-18	5	C. Du Toit	New logos and transmitter position requirements added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.

2007-10-09	3	C. Du Toit	“Minimum” 500 ohm load changed to “Maximum”
2007-06-05	2	C. Du Toit	Revision block updated and ”Joburg” logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

9 LEVEL MEASUREMENT 4

9.1 Scope 4

9.2 Abbreviations 4

9.3 Standards 4

9.4 General Requirements 4

9.5 Surge Protection 6

9.6 Level Measurement – Controller/Transmitter 6

9.7 Level Measurement – Sensor/Transducer 7

9.8 Spares 7

9.9 Labelling 7

9.10 Data Sheets 7

9 LEVEL MEASUREMENT

9.1 Scope

9.1.1 This specification covers the supply and installation of Level meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

9.2 Abbreviations

9.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
CPU	:	Central Processing Unit
UPS	:	Uninterruptible Power Supply
MCC	:	Motor Control Centre
MCB	:	Miniature Circuit Breaker
SPD	:	Surge Protection Device
FJB	:	Field Junction Box
SSO	:	Switched Socket Outlet
SPDT	:	Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
O&M	:	Operating And Maintenance

9.3 Standards

9.3.1 The supply and installation of all Level meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

9.4 General Requirements

9.4.1 This specification must be read in conjunction with the following specifications:-

9.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

9.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

9.4.1.4 Load Cells And Their Installation

9.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

9.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.

9.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

9.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.

9.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).

9.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.

9.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.

9.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

9.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if

instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

9.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

9.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.

9.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.

9.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

9.5 Surge Protection

9.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.6 Level Measurement – Controller/Transmitter

9.6.1 All level measurements must be done by using ultra-sonic distance measurement, which is converted into a level value.

9.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

9.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

9.6.4 The instrument must be equipped with at least three to five SPDT relays, rated for at least 230V AC, 2A, for preset level outputs. These outputs must be user-programmable for various levels.

9.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

9.6.6 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.

9.6.7 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.

9.6.8 The transmitter must have an LCD or LED display showing instantaneous level and relay status.

9.7 Level Measurement – Sensor/Transducer

9.7.1 The range of the sensor must be suitable for the application (see items 9.4.8 and 9.4.9 of this specification).

9.7.2 The sensor must be suitable for an operating temperature range of -10ºC to +50ºC.

9.7.3 The sensor must be equipped with automatic temperature compensation.

9.7.4 The sensor must have a protection rating of at least IP 67 or higher.

9.7.5 Brackets used for the mounting of ultra-sonic sensor heads must be made of at least 3CR12 grade stainless steel.

9.8 Spares

9.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

9.9 Labelling

9.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

9.10 Data Sheets

9.10.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – LEVEL METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 5 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous level & relay status LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details.	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 19 : FIELD JUNCTION BOXES AND PANELS

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 19 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 19 : Field Junction Boxes And Panels**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 19**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	19	C. Du Toit	Cover page updated
2019-08-14	18	C. Du Toit	Use of materials in corrosive areas updated (GRP)
2019-06-25	17	C. Du Toit	Stopper plugs used updated.
2019-06-15	16	C. Du Toit	Cable terminations plus wiring and terminations updated to correspond with that in PLC Panels and
2019-01-28	15	C. Du Toit	Included Cydna requirement for no direct sunlight on display units.
2018-11-30	14	C. Du Toit	Updated reference to Labelling specification, IJBs should not cause obstruction, clearing to be created
2014-04-17	13	C. Du Toit	Updated FJB stands and labelling
2013-10-07	12	C. Du Toit	Updated footer and racking on IJB stands
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Added Polycarbonate boxes and updated labelling requirements.

2012-03-08	9	C. Du Toit	Changed required paint thickness for IJBs, added requirements for supports/brackets and changed (Pty)
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Altered minimum panel powder coating thickness & hinges material.
2010-03-12	6	C. Du Toit	Altered submission time of FJB panel drawings.
2009-08-18	5	C. Du Toit	New logos and data display viewing requirements
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

INDEX

19 FIELD JUNCTION BOXES AND PANELS 4

19.1 Scope 4

19.2 Abbreviations 4

19.3 Standards 4

19.4 General Requirements 4

19.5 Standard Features 7

19.6 Wiring and Terminals 8

19.7 Existing Panels 10

19.8 Factory Acceptance 10

19.9 Over-Voltage/Lightning Protection 11

19.10 Spares 11

19.11 Painting (Powder Coating Method) 11

19.12 Drawings And Diagrams.....12

19 FIELD JUNCTION BOXES AND PANELS

19.1 Scope

19.1.1 This specification covers the manufacturing, supply and installation of Field Junction Boxes, Field Equipment Panels and any other panels used for housing terminals, surge protection devices, instruments, control switchgear (such as pushbuttons, selector switches, indicating lamps, potentiometers, etc.) for process monitoring and control applications at Johannesburg Water wastewater sites.

19.2 Abbreviations

19.2.1 In this specification the following abbreviations will apply :-

BS	:	British Standards
PLC	:	Programmable Logic Controller
I/O	:	Input/Output
MCB	:	Miniature Circuit Breaker
LPZ	:	Lightning Protection Zone
SPD	:	Surge Protection Device

19.3 Standards

19.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	:	National Standards for the wiring of premises.
SANS 1091:2004	:	National Colour Standard.
SANS 1274-2005	:	Coatings applied by the powder-coating process.
BS 381C:1980	:	Paint colour chart.

19.4 General Requirements

19.4.1 The Field Panel will typically house the following items:-

19.4.1.1 Terminals, fuses, MCB's, trunking, surge protection, relays, etc.

19.4.1.2 Pushbuttons, selector switches, potentiometers, indicating lamps, etc.

19.4.1.3 Power supplies, indicating instruments, etc.

19.4.1.4 Instruments such as transmitters.

19.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.

19.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).

19.4.4 For areas other than those mentioned in item 19.4.12 below, the panel should be manufactured from at least 3CR12 grade stainless steel typically not less than 1,5 mm thick. All hinges, locking devices, bolts, nuts and washers must also be at least 3CR12 stainless steel. The panel will have a door on the front which opens to the full width and height of the panel. The panel shall be free standing and the top edge of the panel shall not be more than 1,8m above floor level and it should be sized to accommodate all the associated equipment comfortably.

19.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.

19.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white.

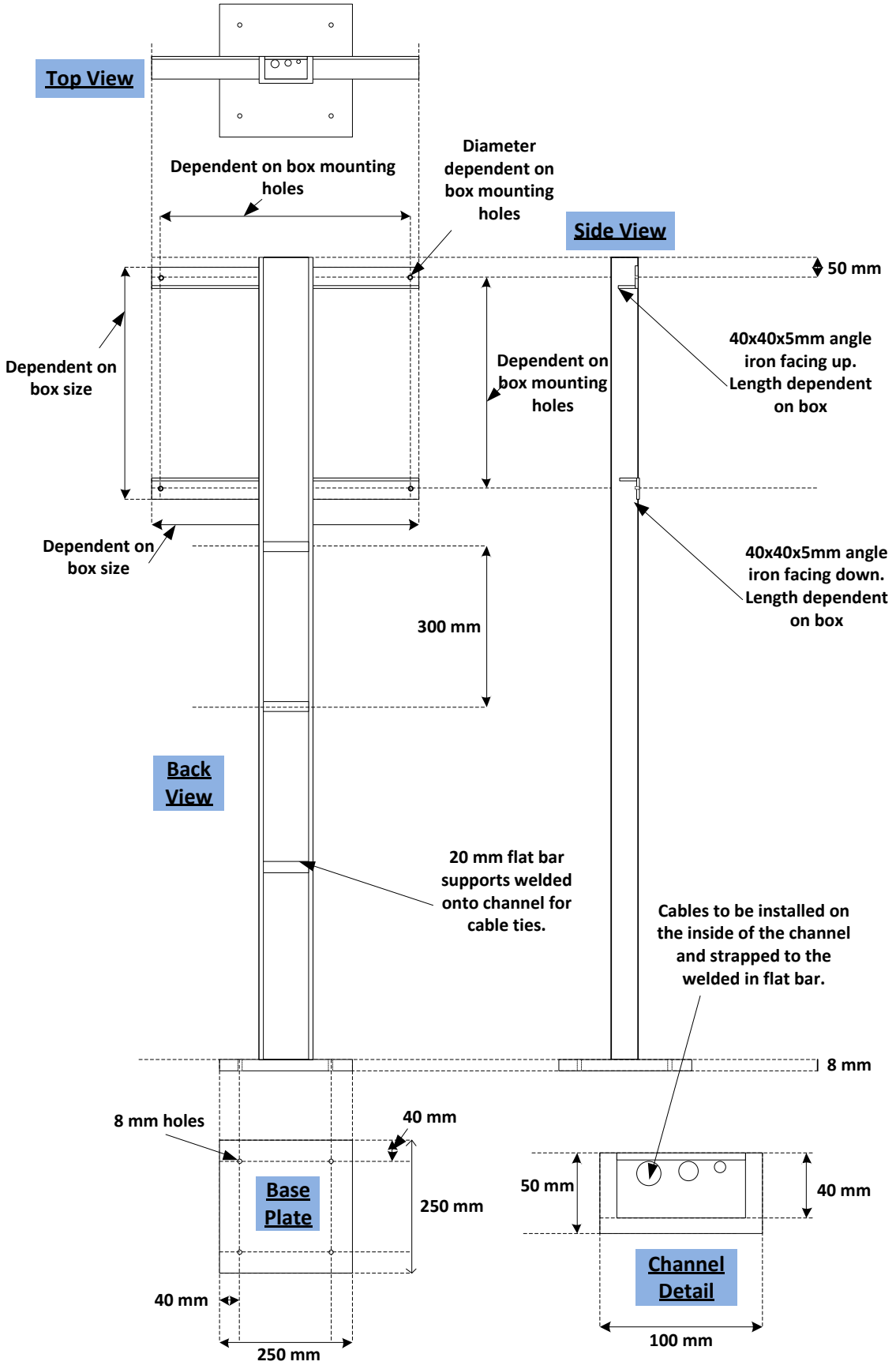
19.4.7 All IJBs should be clearly labelled with labels as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

19.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 65.

19.4.9 Where equipment such as pushbuttons, selector switches, potentiometers, etc. are required on the panel exterior, a double door system must be used. The equipment must be mounted on a hinged door, which in turn is located inside a second hinged door fitted with a transparent panel so that all relevant equipment can be viewed without the need to open this external door. This external door with the glass panel must ensure that the IP 65 protection rating is not compromised by the fitting of equipment such as pushbuttons, switches, etc.

19.4.10 Where outer doors are equipped with transparent panels, such a panel must consist of a material that will not deteriorate significantly due to its exposure to the elements such as ultra-violet radiation, heat, wind, rain, etc. Glass panels will be preferred.

19.4.11 Where there are no existing structures against which the panel can be mounted, a sturdy stand (see the picture below), or mounting bracket must be manufactured of the same material as the panel (i.e. at least 3CR12 grade stainless steel), painted to the same specification and in the same colour as the panel. A ladder type cable rack of suitable width to accommodate all the cabling, plus at least 10% spare space must be fitted to the stand or structure to enable proper securing of the cables, if the cables cannot comfortably be run inside the channel used for the stand or if there is no stand (i.e. where brackets or wall-mounting is used). The cable racking must comply with all the requirements in the Cabling Specification (Volume 6 of the Automation And Control Standards).


Top View
Dependent on box mounting holes
Diameter dependent on box mounting holes
Side View
50 mm
Dependent on box size
Dependent on box mounting holes
40x40x5mm angle iron facing up. Length dependent on box
Dependent on box size
300 mm
40x40x5mm angle iron facing down. Length dependent on box
Back View
20 mm flat bar supports welded onto channel for cable ties.
Cables to be installed on the inside of the channel and strapped to the welded in flat bar.
8 mm
8 mm holes
40 mm
Base Plate
250 mm
50 mm
40 mm
Channel Detail
40 mm
250 mm
100 mm

19.4.12 Field junction boxes used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from Polycarbonate. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel, painted with 2K poly urethane paint, for all these applications. A sample of the panel must be approved by the engineer before manufacturing or purchasing commences. Channels or other sections used for securing of these junction boxes should be made from GRP (Glass Reinforced Polyester). Where transparent covers are used, they must be high visibility Polycarbonate with UV filtration. Since these Polycarbonate panels are used in highly corrosive atmospheres, they must contain as little metal as possible. Hinges, locking devices, etc. wherever possible, should also be Polycarbonate. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.



19.4.13 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m^2, all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.

19.4.14 IJB's shall not be installed such that they obstruct passageways or are close to the road where moving objects such as vehicles, forklifts etc. can damage the IJB.

19.4.15 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

19.5 Standard Features

19.5.1 Each panel shall have the following features as standard:-

19.5.1.1 No ventilation fans shall be mounted in the panel and thereby compromise the protection rating.

19.5.1.2 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the first (i.e. inner) door of a 2-door panel, in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the

panel is not compromised.

19.5.1.3 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.

19.5.1.4 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

19.5.1.5 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

19.5.1.6 A copper earth bar running the width of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires.

19.5.1.7 Terminals and equipment of the same voltage must be grouped together, while terminals and equipment of different voltages must be clearly marked and separated by at least 50mm or by suitable insulated barriers to ensure that inadvertent contact or accidental terminations in the wrong place are avoided. Where such barriers are used between terminals of different voltages, these barriers must be larger than the terminals (i.e. standard terminal end barriers will not be acceptable) to ensure that there is a clear separation and to avoid accidental incorrect terminations.

19.5.1.8 Where the panel will be installed out in the open (i.e. not in an area where it is in the shade), the panel must be equipped with a cover which will provide shade for the panel while allowing air flow between the panel and the cover. Such panels should as far as practically possible be installed to face South and the cover should ensure that all transmitters, analysers, pushbuttons, lamps, etc. are protected from direct sunlight. It must be ensured that transmitter LED/LCD displays are **never** exposed to direct sunlight.

19.5.1.9 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).

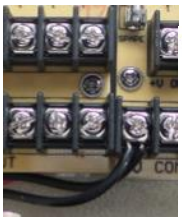


19.6 Wiring and Terminals

19.6.1 All terminals shall be screw type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.

19.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

19.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).






Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

19.6.4 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-

19.6.4.1 1,5mm² for 230V AC or 110V AC power

19.6.4.2 1,0mm² for 24V DC or AC power

19.6.4.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals

19.6.4.4 4,0mm² for earth drain

19.6.5 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.

19.6.6 All wire terminations must be done by using suitable lugs. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.

19.6.7 All panel wiring shall run in suitable sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.

19.6.8 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.

19.6.9 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.

19.6.10 Each analogue and digital input and output to and from the PLC shall have surge protection units as specified in the Clean Power And Surge Protection Specification

(Volume 5 of the Automation And Control Standards).

19.6.11 Internal wiring shall be colour coded as follows:-

19.6.11.1 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

19.6.11.2 24V DC Power

Positive	Red
Negative	Black

19.6.11.3 Digital Inputs

230V AC	Yellow
24V DC	Red

19.6.11.4 Digital Outputs

230V AC	Grey
24V DC	Red

19.6.11.5 Relay Outputs

230V AC	Grey
24V DC	Red

19.6.11.6 Analogue Signals

Positive	Orange
Negative	Purple

19.6.12 A terminal section for AC and DC power distribution shall be included in the panel where both voltages are used for equipment power supplies. The terminal groups shall be clearly identified to indicate the various voltages.

19.6.13 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.

19.7 Existing Panels

19.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

19.8 Factory Acceptance

19.8.1 Before delivery of the panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

19.8.2 The test shall comprise of at least, but not be limited to:

19.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.

19.8.2.2 Layout, numbering and labelling of equipment.

19.8.2.3 Wiring – sizes, numbering, colours, termination, etc.

19.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

19.9 Over-Voltage/Lightning Protection

19.9.1 The function of the over-voltage/lightning protection units is to prevent damage from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

19.9.2 The SPD's on all incoming power supplies to the panel shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. Even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed.

19.9.3 All analogue and digital input and output circuits shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. and even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed. for protection of these circuits.

19.10 Spares

19.10.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

19.11 Painting (Powder Coating Method)

19.11.1 **General**

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.
Unless specified otherwise, a high gloss finish in the following colour shall be provided:
Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.
Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

19.11.2 **Specifications**

The following specifications in accordance with SANS 1274-2005 shall be provided:-

Property	Requirement	Test Method
Thickness, minimum	50 micron	6,7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13

Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

19.11.3 **Surface Preparation**

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.
All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.
A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.
Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned. These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.
The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

19.11.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185ºC so as to melt the powders to form a continuous film over the metal substrate.

19.12 Drawings And Diagrams

19.12.1 The tenderer must submit layout drawings, showing the panel size, cable entry, location of equipment, details of equipment (such as trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm 3CR12 SS), etc. for approval by the Engineer before any manufacturing commences.

19.12.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Treminals - Phoenix SK12, 4mm, white.
MCB's - Merlin Gerin, 5A, 10kA, single-pole.
Etc.

a world class African city

City of Johannesburg
Johannesburg Water SOC Ltd

17 Harrison Street
Johannesburg

Johannesburg Water
PO Box 61542
Marshalltown
2107

Tel +27(0) 11 688 1400
Fax +27(0) 11 688 1528

www.johannesburgwater.co.za

PARTICULAR SPECIFICATION

G01 : COLOUR CODING OF EQUIPMENT

2	2013-10-23	Minor updates and re-issued	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION: VOLUME G01 : COLOUR CODING OF EQUIPMENT

CONTENTS

G01.1 SCOPE 2
G01.1.1 Machined Components 4
G01.1.2 Records 4

G01.2 MEASUREMENT AND PAYMENT 4

G01.1 SCOPE

This Specification has been adopted by Johannesburg Water to ensure the colour coding of electrical equipment, mechanical plant and pipework located on Johannesburg Water's Wastewater Treatment Works shall conform to the ruling Occupational Health and Safety Act.

The Specification comprises of **three** parts, namely:

(a) SANS Code of Practice 10140-3, Identification colour marking – Part 3 : Contents of pipelines: 2003

(b) A table (Table 1) which supplements SANS 10140-3, above, in order to provide greater detail or clarity on the colour marking of pipelines conveying fluids commonly found on the treatment works

(c) A table (Table 2) which gives the colours adopted for certain electrical equipment and mechanical plant.

Throughout the Specification the colours used shall match the corresponding colours given in SANS Specification 1091, National Colour Standards for Paint: 2004 (as amended).

Where a colour code is not covered by this Specification, the matter shall be referred in writing to the Divisional Manager: Investment Delivery for ratification.

Table 1 : Colour Coding of Pipework on Johannesburg Water's Wastewater Treatment Works

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Water, non-drinkable			
Cooling water	Brilliant Green		
Final treated effluent		White	
Recycled effluent		Black	Dark Violet
Air saturated effluent		Black	Dar Violet
Filtrate		Black	Aquamarine
Wash Water		Black	
Scum water		Black	Dark violet
Dewatering Liquors		Black	Dark Violet
Overflow from P.S.T's		Black	Crimson
Overflow from Clarifier		Black	Dark Violet
D.A.F Underflow		Black	Crimson
Supernatant Liquor		Black	Avocado
Overflow Gravity Thickener		Black	Crimson
Fire Fighting			
Boiler feed		Cornflower	
Hydraulic power		Salmon Pink	-
Poly-electrolyte		Light Grey	-
Raw sewage		Middle Brown	-
Settled sewage		Mid-grey	-
Thickener overflow from:			
Primary sludge		Crimson	-
Activated sludge		Canary Yellow	-
Digested sludge		Maroon	-
DAF liquors		Canary Yellow	Turquoise Blue
Filtrate		Ultramarine	-
Washwater		Black	-
Scum water		Dark Violet	Crimson
Treated effluent		Dark Violet	-
Dewatering liquors		Black	Ultramarine
Acids	Jacaranda		
Ferric chloride		Crimson	
Ferric sulphuric		Artic Blue	

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Alkalis			
Lime Slurry	Dove Grey		
Gases			
Sludge gas	Light Stone	Jacaranda	
Steam	Pastel grey	Aluminium	Clad/lagging
Nitrogen	Light Stone	Black	Light Grey
Hydrogen	Light Stone	Black	Signal Red
Methane (digested)	Light Stone	Turquoise Blue	
Carbon dioxide	Light Stone	Light Grey	
Chlorine/Hypochloride	Canary Yellow		
Oxygen	White		
Compressed Air	Artic Blue		
Ventilated Air	Artic Blue		
Vacuum Air	Artic Blue		
Instrument Air	Artic Blue		
Sludges			
Anaerobically digested	Middle Brown	Maroon	
Anaerobically digested: thickened		Maroon	Light Grey
Raw Sludge	Dark Violet		
Lime treated	Dark Brown	Dove grey	
Primary	Dark Brown	Crimson	
Primary thickened	Dark Brown	Crimson	
Digester supernatant liquor	Middle Brown	Salmon Pink	
Activated : mixed liquor	Royal Blue	Canary Yellow	
Activated : gravity thickened	Royal Blue	Canary Yellow	Dark Violet
Activated : return sludge	Royal Blue	Canary Yellow	Middle Brown
Activated : DAF overflow/float	Royal Blue	Canary Yellow	Turquoise Blue
Activated : primary	Royal Blue	Canary Yellow	Crimson
Activated : digested	Royal Blue	Canary Yellow	Maroon
Activated : waste	Royal Blue	Canary yellow	
Pasteurised	Light Brown		
Oil			
Diesel oil	Black	White	
Hydraulic oil	Golden brown	Salmon Pink	
Lubricating	Golden brown	Brilliant Green	
Transformer	Golden brown	Crimson	
Other Liquids			
Polyelectrolyte	Golden Yellow	Jacaranda	
Cooling liquid	White		

Notes: This table supplements SANS 10140-3: 2003

All codes are in relation to SANS 1091: 1975

Table 2: Colour Coding of Electrical Equipment and Mechanical Plant

Item	Colour	Remarks	Code to SANS 1091
Electrical panels : (external)	Light Orange	NOSA	B.26
Electrical panels : (external) emergency power on	Signal Red		A.11
Electrical panels : (Internal)	White		G.80
Coupling guards and motor guards	Golden Yellow	SANS 10140-2	B.4
Motor cowls	Light Orange	Historical	B.26
Electrical motors, pumps and compressors	Deep Pastel Green		H.28
Gearboxes	Navy Light Grey	NOSA: See also "Small Gearboxes"	G.35
Blower	Deep Pastel Green	NOSA	H.28
Baseplates	Olive Drab		
Cranes	Golden Yellow		B.4
Valve bodies		See SANS 10104-3, Clause 4.2	
Valve hand-wheels			
Small gearboxes	To be same colour as prime mover		

G01.1.1 Machined Components

All machined components shall be protected by "Tectyl" or similar proprietary coating after manufacture. The coating shall be sufficiently durable to prevent corrosion during storage and installation and shall be removed using the manufacturers recommended solvent after final adjustment of the equipment. Final paining shall be carried out in accordance with the system specified.

G01.1.2 Records

The contractor and sub-contractors shall maintain records of the application environment, dates of applications, conditions of surfaces before preparation, blast profiles, wet and dry film thicknesses, overcoating times, paint types and batch number, method of application, tests and type of instruments used, which shall be incorporated into the Component Quality Plan and be available to the Engineer or his Representative for review and surveillance. Two copies of the completed Component Quality Plan shall be provided within 2 weeks of completion of the corrosion protection system.

G01.2 MEASUREMENT AND PAYMENT

For the purpose of this Contract the electro-mechanical items shall be supplied and installed conforming to this specification. The cosmetic panting application shall be included for and the surface preparation, transporting of equipment to and fore from the applicator shall be included for. No separate measurement item shall be included for the application of these coatings.

a world class African city

City of Johannesburg
Johannesburg Water SOC Ltd

17 Harrison Street
Johannesburg

Johannesburg Water
PO Box 61542
Marshalltown
2107

Tel +27(0) 11 688 1400
Fax +27(0) 11 688 1528

www.johannesburgwater.co.za

PARTICULAR SPECIFICATION

G02: CORROSION SPECIFICATION

2	2013-10-23	Minor updates and re-issued	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E01 : ELECTRICAL MOTORS

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E01 : Electrical Motors**

JW Reference: **BWW523C**

Document Ref. No: **E01**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E01: ELECTRICAL MOTORS

CONTENTS

E01.1 SCOPE 4

E01.2 INTERPRETATIONS 4
E01.2.1 Abbreviations 4
E01.2.2 Standards 4

E01.3 GENERAL REQUIREMENTS 4

E01.4 WORKING VOLTAGE AND SUPPLY SYSTEMS 5

E01.5 TEMPERATURE RISE 5

E01.6 EFFICIENCY AND POWER FACTOR 5

E01.7 VIBRATION 5

E01.8 NOISE LEVEL 5

E01.9 ENCLOSURE AND FRAME 5

E01.10 MOTOR TYPE 6

E01.11 RATING AND STARTING REQUIREMENTS 6

E01.12 BEARINGS 6

E01.13 EARTHING 7

E01.14 HEATERS AND DRAINAGE 7

E01.15 TERMINAL ARRANGEMENTS 7

E01.16 MOTOR/LOAD COUPLING 8

E01.17 INFORMATION PLATES FOR MOTORS 8

E01.18 ADDITIONAL SPECIFICATIONS FOR TWO-SPEED MOTORS 8

E01.19 SUBMERSIBLE MOTORS 8

E01.20 ADDITIONAL REQUIREMENTS 9

E01.21 TECHNICAL DATA SHEETS 9

E01.22 TESTING 9
E01.22.1 Performance Tests 9
E01.22.2 Routine Tests 10
E01.22.3 Test Certificates 10
E01.22.4 Witnessing of Tests 10
E01.22.5 Testing of Terminal Box Assembly 10

E01.23 DRAWINGS FOR APPROVAL 10

E01.24 STORAGE 10

E01.25 ERECTION AND INSTALLATION 11
E01.25.1 Erection 11
E01.25.2 Bearing Inspection 11
E01.25.3 Alignment 12
E01.25.4 Drying Out 12

E01.25.5 Double Shaft Extensions 12

E01.26 TESTING AND COMMISSIONING 12

E01.27 MEASUREMENT AND PAYMENT 12

E01.1 SCOPE

This specification shall cover all electric motors to be designed, supplied installed and tested that shall drive any of the items of equipment to be supplied under the contract. This specification shall be read together with those specifying the mechanical driven equipment.

E01.2 INTERPRETATIONS

E01.2.1 Abbreviations

In this Specification, the following abbreviations will apply:

ANSI : American National Standards Institute
ASTM : American Society for Testing and Materials
BS : British Standards Institution
SANS : South African National Standards

E01.2.2 Standards

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 1804-2 : Low-voltage three-phase standard motors

(b) SANS 60529 : Degrees of protection provided by enclosures (IP code)

(c) SANS 60034 : Rotating electrical machines

(d) BS 1486-2 : Heavy duty lubricating nipples

(e) SANS 60034-1 : Rotating electrical machines Part 1: Rating and performance

(f) ISO 281 : Rolling bearings - dynamic load ratings and rating life

E01.3 GENERAL REQUIREMENTS

(a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SANS 1804-2.

(b) Imported motors shall be accepted only if they form an integral part of the equipment offered. Where imported motors are offered they shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 1804-2.

(c) The Engineer shall be provided with the appropriate certificates obtained from the South African National Standards stating that such motors do comply, prior with the installation of the motors. However, where tests reveal that motors do not comply, it shall be the responsibility of the Contractor to supply alternative motors that comply with the requirements of SANS 1804-2.

(d) Where imported motors are not normally kept in stock in South Africa, written proof shall be provided of the availability of replacement parts as well as the delivery period of the parts after placing the orders.

(e) All motors shall be standard catalogue models and shall be readily available.

(f) All motors shall where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.

(g) All motors shall be wound for direct-on-line (DOL) type of starting.

E01.4 WORKING VOLTAGE AND SUPPLY SYSTEMS

(a) The motors shall be capable of operating within ± 10% of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage system under actual service conditions, including the ± 10% voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

(b) All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between ± 5% of the nominal supply voltage.

(c) The slip-in speed of any motor at 80 percent of the nominal voltage at 50Hz shall not exceed a percentage agreed on by the engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

E01.5 TEMPERATURE RISE

The temperature rise, as determined by resistance, of all motors, shall not exceed the following derated values:

Insulation class	E	B	F	H
Temperature rise (K)	50	60	80	100

E01.6 EFFICIENCY AND POWER FACTOR

(a) All motors supplied will be energy-efficient as described in SANS 60034-31: Selection of energy-efficient motors

(b) The efficiency of all motors shall be guaranteed by the contractor. Deviations from the guaranteed efficiency shall be within the limits specified in SANS 1804-2.

(c) The guaranteed efficiency of each motor size and rating shall be as determined in accordance with SANS 60034. A basic test certificate of efficiency will be accepted for a motor of identical size and rating or a basic test of efficiency shall be conducted if no certificate is available.

(d) The power factor of motors with a capacity of 20 kW or more shall not be less than 0,85 under all operating conditions.

E01.7 VIBRATION

(a) Motors shall be statically and dynamically balanced.

(b) All motors shall be checked for inadvertent vibration without load, and at full rated voltage at the manufacturer's works, and the vibration amplitude as measured shall be in accordance with SANS 60034-1.

(c) The ratio of axial to radial vibration shall not exceed 0,5.

E01.8 NOISE LEVEL

Unless specified differently all motors shall be of 'normal sound power', in compliance with SANS 60034.

E01.9 ENCLOSURE AND FRAME

(a) Each motor shall be ingress protected to the degree required by its application, and its enclosure shall be designed for the system of cooling associated therewith.

(b) Notwithstanding the requirements above, the minimum degree of protection shall be IP 55 to SANS 60529, or alternatively specified. Motors shall preferably be of the totally enclosed fan-cooled (TEFC) type.

(c) The motor cooling system must be of an aerodynamic design with minimal noise levels and superb airflow distribution over the frame with superior mechanical strength. All motor

cooling fan covers will be constructed in metal.

(d) All motors of the vertical-spindle type and exposed to the weather, shall be provided with a robust canopy of approved design by the Engineer.

E01.10 MOTOR TYPE

Motors shall be of the squirrel-cage induction type. Slip-ring induction motors or other approved types will be considered if the contractor is of the opinion that better results could be obtained by using such motors. Full electrical and mechanical details of each alternative shall be submitted with the tender documents. Alternative motors must be accepted by the Engineer in writing.

When motors are connected to VFD's with variable torque loads operated under usual service conditions, inverter-ready general-purpose motors must be supplied (IEC 60034-1)

When motors are connected to VFD's operating at extremely low speeds and/or with a constant torque load, or when operating over base speed, definite-purpose, inverter-duty motors must be supplied (IEC 60034-1).

Larger inverter-duty motors must be equipped with a constant speed auxiliary blower to provide adequate cooling at low motor operating speeds. The contractor must submit a statement from the motor supplier on the need for an auxiliary blower when omitted.

Inverter-duty motors above the 500 frame size should have both bearings insulated, and be equipped with a shaft grounding brush with a ground strap from the motor to the drive case. For frame sizes below 500, the contractor must check with the motor manufacturer regarding requirements for motor bearing insulation.

E01.11 RATING AND STARTING REQUIREMENTS

(a) Motors shall be adequately rated for the service for which they are intended, and due allowance shall be made for the temperature, altitude, climatic conditions and variations in the supply voltage. Motors shall not exceed 120% of the required capacity without prior approval from the Engineer.

(b) Not only shall motors be based on the full load requirements, but also the motor capacity and starting characteristics shall be compatible with the requirements of the driven equipment.

(c) Where motors are required to drive high inertia loads, the starting torque of the motor and the torque curve of the driven load shall be submitted to the Engineer for approval prior to manufacture. Such motors shall be capable of at least three starts per hour, with two consecutive starts from normal operating temperature, or more frequently if required by the Engineer.

(d) Motors shall be of the continuously running duty class S1 unless otherwise specified in the detailed specification or if a more onerous duty is dictated by the drive requirement.

(e) All squirrel-cage induction motors shall be suitable for direct on line starting at full voltage. Single-speed motors shall conform to SANS 60034-12, Design B characteristics unless approved by or dictated by the drive requirements.

(f) Unless otherwise approved, the 15% tolerance on locked-rotor torque permitted by SANS 60034-1 will not be accepted and shall be limited to 10%.

(g) Documentation shall include performance curves to suit the designed working conditions.

(h) When making a selection of the motor size for driven equipment, motor power shall be over-rated by a factor of thirty percent (30%) more than the demand of the driven equipment.

E01.12 BEARINGS

(a) All motors shall, wherever possible, be provided with pre-lubricated sealed bearings.

(b) Re-greasable bearings shall require only one lubrication per year. Grease lubrication of ball or roller bearings, where approved, shall be by means of hexagonal button-type grease

nipples to BS 1486- 2, Nos. 21A or 21B (industrial type).

(c) Grease-lubricated bearings shall have relief holes to ensure that the bearings have been correctly packed, which holes shall be positioned so that the excess grease can be easily removed. Cups shall be fitted to contain excess grease.

(d) Bearings shall be protected against eddy currents and shall be capable of withstanding vibrations caused by unbalanced loads.

(e) All bearings shall be designed for a minimum L_{10h}, basic life rating of 50 000 hours at the rated load and speed for the application in accordance with ISO 281.

E01.13 EARTHING

All motors shall be provided with a machined or spot-faced boss earth point, tapped to receive a bolt of not less than 10 mm in diameter for earthing purposes. This earth point must be located on one side of the motor, between the mounting feet.

A protective earth cable must be installed between the MCC earth bar and the motor earth point, sized in accordance with SANS1042-1.

Earth bonding must be installed between the motor frame and the motor support structure as well as the cable support structure.

E01.14 HEATERS AND DRAINAGE

Non-submersible motors that will be located outdoors or in a damp location such as in a drainage sump shall be provided with suitable means of drainage to prevent the accumulation of water due to condensation. They shall also be fitted with anti-condensation heaters suitable for a 220V AC supply if considered advisable by the manufacturer.

All motors shall be supplied with anti-condensation heaters (220V AC supply) to keep the motor temperature at 23°C when the motor is not operational to prevent moisture from condensing in the motor unless specified otherwise.

Heater terminal boxes shall be fitted on the motor frame and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

E01.15 TERMINAL ARRANGEMENTS

(a) All motor terminal boxes must be oversized to fit a cable one size bigger than the standard cable as a minimum

(b) The terminal box must be installed with an OME supplied seal between the terminal box and the motor chassis

(c) Motor cable termination blocks must confirm to the IEC 60034-1 standard

(d) The line connections of each motor shall be brought out to a terminal box located in an approved position. In the case of two-speed motors, separate terminal boxes shall be provided for each speed.

(e) Terminal boxes shall be of the totally enclosed type designed to exclude the ingress of dust and moisture and sealed from the internal circuit of the motor, and shall be manufactured from sand-cast metal. The wall thickness of the terminal boxes and the dimension of the cable inlet shall be as specified in SANS 1804-2. The terminal box shall be so designed that the cable entry may be made in any one of four positions placed at right angles to one another.

(f) Winding termination in the motor terminal boxes shall be properly secured or fastened to avoid hot connections during operation.

(g) Terminal boxes shall be of ample size to allow the cable to be terminated in the box. Under no circumstances shall the cable be allowed to be in contact with the inside of the box or lid.

(h) Terminals shall be of a substantial design and shall be suited to receive cable lugs. Pinch-screw connections will not be accepted.

(i) The terminal arrangement shall permit the motor to be disconnected from its supply cable without damaging the cable tails and shall allow the supply cable and motor windings to be tested separately.

(j) The electrical clearance and creepage distances, with the correct cable terminations in position, shall comply with the requirements of SANS 60034.

(k) Terminal markings shall be clear and permanent. Irrespective of the direction of rotation required on the site, the connections shall be such that, when the supply leads L1 - L2 - L3 are connected to the motor terminals U - V - W respectively, the motor shall rotate in a clockwise direction when viewed from the driving end.

(l) Motors suited for only one-directional rotation, shall be clearly marked as such by an arrow fixed to the motor frame at the driving end.

(m) Before the contractor orders terminal boxes for electrical equipment, he shall supply details of the proposed boxes to the engineer for approval. These precautions are necessary to ensure that the size of the connecting blocks installed is sufficient to accommodate the cables supplied and connected by another contractor, and that sufficient space exists within the box to route cables conveniently.

E01.16 MOTOR/LOAD COUPLING

(a) Motors shall be coupled direct to the equipment to be driven by means of approved couplings and/or gearboxes unless specified differently. Refer to the relevant sections for specific specifications on transmission couplings and gearboxes. Vee-belt and chain drives will be considered only if direct coupling of the motor to the equipment is impossible or impractical.

Motors driving vee-belt or chain drives shall be fitted with heavy-duty bearings suited to the full side thrust at 120% of full load torque and short-term overloads of up to 250% of the full load torques during starting. The stiffness of the rotor shaft shall be checked to ensure that resonance and fatigue do not occur.

(b) Where applicable, the flanges of the motors and equipment shall be identical.

(c) The precision tolerance class shall apply to all flange-mounted motors with regard to concentricity, perpendicularity and shaft run-out.

E01.17 INFORMATION PLATES FOR MOTORS

In addition to the information required by SABS 948-1the following shall also be marked on the nameplates:

(a) Year of manufacture,

(b) The order number,

(c) Total mass of motor in kilogram,

(d) Diagram indicating the number, type and positions of heaters and temperature detectors if applicable,

(e) Bearing types and sizes, and

(f) Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

E01.18 ADDITIONAL SPECIFICATIONS FOR TWO-SPEED MOTORS

The following additional specifications apply to all two-speed motors:

(a) Terminal markings shall be as per SANS 1804-2.

(b) The starting current shall not exceed six times the full load current of the high-speed rating.

E01.19 SUBMERSIBLE MOTORS

The following additional requirements apply specifically to all submersible motors:

All submersible motors shall be suited for submersion up to a depth of 1,5 times the depth of submersion shown on the drawings for each application, or as specified in the detail specifications.

All submersible motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the motors.

An adequate length of waterproof cable, purpose-made for submersion, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimize any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.

Thermistor protection temperature switches shall be provided for submersible motors.

Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed included in the rates tendered for the equipment.

E01.20 ADDITIONAL REQUIREMENTS

(a) The rotation speed of motors shall not exceed 1 500 rpm unless approved by the Engineer.

(b) Thermistor protection shall be provided for each winding of each motor. Motors rated below 22kW shall have no thermistor and heater protection devices installed on them. Motor rated 22kW and above shall have both thermistor and heater protection devices installed on them.

(c) Motors below 55kW shall be started by the DOL type method of starting. Motors including 55kW and above shall be started by the softer-starter type method of starting.

(d) A separate thermistor and heater terminal box shall be fitted on the motor frame next to the power terminal box and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

(e) The minimum preferred class of insulation is Class F, derated in accordance with the relevant clause above.

E01.21 TECHNICAL DATA SHEETS

Details of all individual electric machines and equipment requiring electrical energy shall be indicated on the technical data sheet provided for in the tender Schedules (included in the technical data sheets.

E01.22 TESTING

Tests on completion (commissioning tests) shall be performed as described below in this specification.

E01.22.1 Performance Tests

(a) One motor of every type shall be tested for temperature rise and excess torque. Type test certificates on identical motors will be acceptable in lieu of these tests. Should type test certificates not be available, the first motor of each size manufactured shall be tested. All tests shall be in accordance with SANS 60034.

(b) The measurement of the temperature rise of the stator windings of motors for use on voltages up to 1 000 volts shall be by the increase in resistance method as is now permitted by SANS 60034.

E01.22.2 Routine Tests

(a) Each motor shall be tested at the manufacturer's works for light-run, locked rotor, insulation resistance, high voltage, air-gap clearances and Tan Delta on each complete stator.

(b) All tests shall be in accordance with SANS 60034.

E01.22.3 Test Certificates

(a) Four copies of all test certificates, showing the results of all tests performed, shall be supplied at a date not later than the delivery date of the motors.

(b) The test certificates shall contain power factor and efficiency figures for 125%, 100%, 75%, 50% and 25% of full load conditions as calculated from the test results.

E01.22.4 Witnessing of Tests

All type and routine tests on motors larger than 45 kW shall be witnessed by the Engineer.

E01.22.5 Testing of Terminal Box Assembly

(a) Proof shall be given to show that a prototype terminal and cable box assembly of the type being supplied on medium voltage motors has been tested under internal short-circuit conditions and that the pressure relief diaphragm ruptured protecting the case of the terminal box from serious damage. In addition, that a through fault current test was made to demonstrate that the complete assembly is capable of handling the short-circuit current without damage. The fault current for these tests shall have been 45 000 ampere for a duration of 0.25 seconds.

(b) These type tests shall have been witnessed by an independent authority.

E01.23 DRAWINGS FOR APPROVAL

The following drawings shall be submitted for approval:

(a) Dimensioned outline and foundation drawings of the motors. (Shaft diameter, shaft height and motor weight to be clearly shown).

(b) Detailed drawings of the bearing arrangement, showing all lubrication pipes, coolers and pumps.

(c) Cross-sectional dimensioned drawings of the cable boxes.

(d) Detailed drawings of the motor base plate showing full constructional details with dimensions.

(e) For motors of 250 kW and larger fully dimensioned drawings of the shaft showing all tolerances.

(f) For motors designed for voltages of 3.3 kV and above, drawings showing the end winding bracing arrangements.

E01.24 STORAGE

The contractor must ensure that the storage requirements as specified by the manufacturer are adhered to strictly so as avoid voiding of the warranty. Every effort must be taken to ensure the motor is protected against ingress of water, vermin or anything that may affect its future operation. The following are only given as guidelines, the contractor is expected to exercise due care in the storage and handling of electric motors.

(a) The motor should be store upright in its normal position, free of dust, dirt, gasses and corrosive atmospheres.

(b) Motors should be stored under roof on a concrete base, normally in a store environment. Do not remove the motor from the wooden pallet.

(c) For bigger units, which cannot be housed in a store or relevant building, shed must be built with a proper concrete floor. Do not remove the motor from the wooden pallet.

(d) Store the bigger units close to the final position within access with overhead crane or mobile crane.

(e) Do not stack any objects on top of or against the motor.

(f) Motors must be stored in places free from vibrations in order to avoid damage to the bearings.

(g) The motors space heaters/ anti condensation heaters and similar accessories must be switched on at all times to avoid condensation and corrosion within the enclosure.

(h) If painting has been damaged during transportation, it must be repainted to avoid rusting.

(i) Ensure all machined surfaces and shaft extensions are covered with grease or a rust inhibiting substance.

(j) For slip-ring motors, the brushes must be lifted to avoid condensation between contact surfaces and slip rings.

(k) Before operation all brushes and contact surfaces have to be inspected and brush seating confirmed.

(l) When any motor is kept for extended period, the shaft must be manually turned on monthly intervals.

(m) For big machines with frames greater than or equal to 400mm, the shaft should be rotated monthly at any number of turns and then put at rest at 180 degrees difference from previous stationary position.

(n) When a motor is not immediately required in operation, it should be protected against moisture, high temperature and impurities in order to avoid damage to the insulation system.

(o) If the ambient contains high humidity, periodical insulation resistance inspection is recommended during storage.

(p) The following guidelines show the approximate insulation resistance values that can be expected from a clean and dry motor at 40° Celsius ambient.

(q) Minimum insulation resistance = rated voltage (kV) + 1 (Mega ohm) using 2 times the rated voltage.

(r) These periodical measurements should be recorded and be available prior to installation.

E01.25 ERECTION AND INSTALLATION

E01.25.1 Erection

(a) When motors are erected, care shall be taken to ensure that adequate tolerance margins are made available to ensure interchangeability with replacement motors.

(b) A minimum of 10 mm of packers shall be provided under the motor frame or motor bedplate to allow for adjustments in height.

(c) Before holding-down bolts are grouted in, the motor shall be lined up and the bolts shall be properly centred in the hole of the bedplate.

(d) The bending radius of the motor supply cable should not be exceeded when installing the cable (SANS10142-1).

(e) Motor supply cables must be supported and should not hang from the terminal box/gland.

E01.25.2 Bearing Inspection

(a) The Engineer shall inspect motors having ball/roller bearings.

(b) The grease shall be examined to ensure that it is not hard.

(c) Providing that no roughness is felt when the shaft is rotated by hand and that the motor runs without undue noise or vibration, the bearings will be considered acceptable.

(d) Should the bearings fail or exhibit the symptoms of brinelling during the guarantee period,

the Contractor, free of charge, without delay, shall change them.

E01.25.3 Alignment

(a) After erection, the alignment of the half-couplings between the motor and the driven machine shall be measured. In the case of a pedestal, bearing motor the air gap clearance between the rotor and the stator shall also be measured. A record shall be kept of these figures and they shall be submitted to the Engineer for approval.

(b) A horizontal sleeve bearing or limited end-float roller bearing motor shall be run uncoupled from its load to ensure that it rotates at the axial position indicated on the shaft and that the rotor is free to move to either side of this position. Particular attention shall be paid to ensure that the free running position and the rotor end-float are in agreement with the axial movement of the flexible coupling.

E01.25.4 Drying Out

(a) The Contractor shall dry out all motors larger than 100 kW and all smaller motors which have stood in the open during rain or have been flooded or whose cold insulation resistance is below 1.5 MΩ, before they are connected to the supply. If a motor is flooded, the motor bearings shall be replaced as a matter of urgency.

(b) The method of drying the motor shall be by placing the motor in a heating oven.

Sufficient heat shall be applied to produce a temperature of 60ºC but not greater than 80ºC for a Class A or 90º C for Class B insulation systems. 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 four hours after the resistance readings have started to rise from the steady minimum value, providing that the winding temperatures have remained steady during this period.

(c) The Contractor shall provide all equipment and the personnel required for the drying-out operation.

(d) In the case of motor smaller than 100kW, the onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply.

(e) Any motor, which fails as a result of being commissioned in a damp condition, shall be repaired at the cost of the Contractor.

E01.25.5 Double Shaft Extensions

The unused shaft extensions of a double-ended shaft motor shall be covered with an approved rust preventative after the motor is commissioned.

E01.26 TESTING AND COMMISSIONING

The contractor must supply a Manufacturers Test Certificate with each motor supplied.

The contractor must do a visual inspection as well as an insulation test on each motor before installation.

The contractor must do a direction test on each motor before handing the installation over. Where equipment can be damaged when rotated in an incorrect direction, the equipment must be disconnected from the motor before the direction check is done.

All test results must recorded and submitted to the Engineer for approval. The Engineer must be informed timeously off all tests to allow witnessing.

E01.27 MEASUREMENT AND PAYMENT

No separate payment will be made for electric motors for equipment unless otherwise specified in the detail specifications. All direct and indirect costs associated with such motors shall be deemed included in the rates tendered for the equipment.

Where separate payment is required for electric motors and specified as such in the detail

specifications, the following payment items shall be applicable:

Item **Unit**

Supply and delivery electric motors ..... No

The unit of measurement shall be the number of motors supplied.

The tendered rate shall include full compensation for the design, manufacture, corrosion protection, supply, handling, transport, testing and delivery of each complete motor as specified in the detail specification to ensure satisfactory operation after installation.

Separate items will be scheduled for different sizes/types of motors required.

Item **Unit**

Installation, test and commission of electric motors ..... No

The unit of measurement shall be the number of motors installed.

The tendered rate shall include full compensation for the installation and coupling of the motor to the required load. The tendered rate shall include full compensation for all required installation material.

Separate items will be scheduled for different sizes/types of motors required.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E02 : ELECTRICAL CABLE RACKS

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 5

August 2019

City of Johannesburg
Johannesburg Water (Pty) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E02 : Electrical Cable Racks**

JW Reference: **BWW523C**

Document Ref. No: **E02**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
4	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E02: ELECTRICAL CABLE RACKS

CONTENTS

E02.1 SCOPE 3
E02.1.1 Statutory Documents and Standards 3
E02.1.2 Particular Specifications to be read in conjunction with this specifications 3

E02.2 CABLE LADDER MATERIAL 3

E02.3 CABLE LADDER ACCESSORIES 4
E02.3.1 General 4

E02.4 INSTALLATION 4

E02.5 EARTH BONDING OF CABLE RACKING 5

E02.6 CORROSION PROTECTION 5
E02.6.1 Powder Coating Systems 5

E02.7 INSPECTION 6

E02.8 MEASUREMENT AND PAYMENT 6

E02.1 SCOPE

This specification covers the supply, delivery and installation of cable ladders for industrial installations. Only cable ladders are to be supplied. Cable trays shall not be acceptable. Cable ladders are not recommended for large cables and open ground as they expose the cable to theft.

E02.1.1 Statutory Documents and Standards

Cable ladders shall be manufactured in accordance with the requirements of the latest editions of the following standards:

(a) SANS 10044	:	Welding
(b) SANS 10064	:	Preparation of steel surfaces for coating
(c) SANS 1274	:	Coatings applied by the powder process
(d) SANS 10162-1	:	The structural use of steel Part 1: Limit-states design of hot-rolled steelwork
(e) SANS 10162-2	:	The structural use of steel Part 2: Limit-states design of cold-formed steelwork
(f) SANS 10162-4	:	The structural use of steel Part 4: The design of cold-formed stainless steel structural members
(g) SANS 10142-1	:	The wiring of premises Part 1 – Low voltage Installations

E02.1.2 Particular Specifications to be read in conjunction with this specifications

This specification shall be read in conjunction with the following specifications:-

(a) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E02.2 CABLE LADDER MATERIAL

All cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.

Cable ladders used inside Elutriation Terrace pump stations or in areas within 50m or less of Ferric Chloride, Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester) in which vinylester resin is used. All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used. Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should as far as possible be made from the same GRP material. Where this is not possible, 316 grade stainless steel support systems shall be used for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used.

Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack

is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange. If GRP ladder racking (as described in item 6.5.2 above) is cheaper than 3CR12 grade ladder racking, the GRP racking should be used inside de-watering buildings as well.

Cable ladders used for all applications other than those mentioned above shall be heavy-duty metal cable ladders, manufactured from 3CR12 grade, powder coated, stainless steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.

E02.3 CABLE LADDER ACCESSORIES

E02.3.1 General

Cable ladder accessories shall be considered to be horizontal bends, vertical bends, internal bends, external bends, Tee-pieces, cross-pieces, reducers (transition pieces), support struts and fasteners. The accessories shall have dimensions that correspond to the dimensions of the linear sections to which they are connected. The radii of all bends shall be 1 m minimum.

The inside dimensions of horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables are not exceeded. Sharp angles shall be 45º metered.

E02.4 INSTALLATION

Cable ladders shall be installed within accessible civil constructed cable ducts. These ducts may form part of the scope of works or may be existing.

Cable ladders are required to be installed within the cable ducts in the motor control centre rooms, on site electrical reticulation, and on access platforms to the mechanical equipment.

Cable ladders shall be installed within accessible cable ducts and shall be supported by a strut channel section securely fixed to the wall. The corrosion protection shall be of the same system as that of the cable ladder. Only vertical installation of cable ladder will be allowed in cable ducts. All cable must be installed on cable ladders and no loose cables will be accepted.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers. Unless otherwise agreed, drilling into or welding onto metal columns, trusses and other metal building structures are not allowed and suitable clamps must be used to fix the cable ladders to the building structure.

The platform mounted cable ladder reticulation shall be installed at minimum of 150 mm from the supporting concrete structure.

Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

All cable ladders shall be spliced with splice sets. The corrosion protection of splices shall be of the same system as that of the cable ladder.

All cable racks not installed in closed ducts or inside buildings will be installed with flat (vertical installation) or peaked covers (horizontal installation). The corrosion protection of covers shall be of the same system as that of the cable ladder.

All cable ducting must be covered with anti-theft covers. All exposed cable on cable ladders must

be covered with anti-theft covers.

All overhead cable ladders crossing a walkway must be at least 2000mm above floor level.

Structural designs must be done for any cable bridges. Support material must be corrosion protected to the same standard as the cable ladder. The design must be approved by the Engineer.

E02.5 EARTH BONDING OF CABLE RACKING

All cable rack joints must be equipotential bonded. Both the ends of cable racking must be bonded to an equipotential bonding bar. Where cable racks enter a lighting protected structure, the bonding conductor must be connected to the rack as close as possible to the point of entrance. All bonding conductors must be equal to 6 sq. mm copper PVC insulated wire.

The bonding conductor cable will be a composite stranded cable made up of tinned copper wires and galvanised steel wires that are braided-interwoven to form the cable. The complex braided and interwoven wires of steel and copper make it very difficult to separate and is unattractive and uneconomical to copper thieves and scrap dealers. The conductor must be insulated in clear PVC.

E02.6 CORROSION PROTECTION

All cable ladders and the cable ladder accessories shall be coated as specified below.

The preparation of the metal surfaces of the cable ladders and cable ladder accessories shall be in accordance with the latest edition of SANS 10064, prior to the application of protective coating.

Corrosion protection shall conform to the coating system stated below:

E02.6.1 Powder Coating Systems

All cable ladder shall be coated in the colour B26 – orange

E02.6.1.1 Paint System 1: Powder Coating, seven (7) stage zinc phosphate treatment, pure epoxy primer, polyester finishing coat, thickness 140 µm.

Paint System	Host Material	Preparation	Primer Coat	Finishing Coat	Dry film Thickness
			(70 µm)	(70 µm)	(µm)
No 1	304 L SS	7 stage zinc phosphate pre-treatment	Epoxy	Epoxy	140

E02.6.1.2 Upon the completion of the corrosion protection specified, the Contractor shall be required to perform the following quality control testing procedures:-

- Impact testing in accordance with SABS 6: Part J,
- Cross hatch adhesion test
- Bend test

E02.6.1.3 The corrosion protection shall form part of the quality control system as approved by the Engineer and the Tenderer shall submit a certificate of compliance upon the delivery of all cable rack supplied. The tenderer will supply a sample of all cable rack to Johannesburg Water for testing purposes.

E02.6.1.4 Epoxy Powder Coat Products

Item	Product type	Powder – Lak
1	Epoxy primer	23-007
2	Pure Epoxy / Polyester finishing coat	Series 3000

E02.7 INSPECTION

After installation, a visual inspection should be conducted with the Engineer. The contractor must compile a butt list with all items not to the satisfaction of the Engineer.

E02.8 MEASUREMENT AND PAYMENT

Item	Unit
Supply and deliver cable ladder	m

The unit of measurement shall be per linear length in meter of cable ladder supplied and delivered. Separate items shall be scheduled to include for each size of cable ladder required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cable ladder.

Item	Unit
Install cable ladder	m

The unit of measurement shall be per linear meter of cable ladder installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cable ladders installed under the Contract.

Item **Unit**

Supply and deliver horizontal bends ..... No

The unit of measurement shall be the number of horizontal bends supplied and delivered. Separate items shall be scheduled to include for each size of horizontal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete horizontal bends.

Item **Unit**

Install horizontal bends ..... No

The unit of measurement shall be the number of horizontal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size horizontal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the horizontal bends installed under the Contract.

Item **Unit**

Supply and deliver vertical bends ..... No

The unit of measurement shall be the number of vertical bends supplied and delivered. Separate items shall be scheduled to include for each size of vertical bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete vertical bends.

Item **Unit**

Install vertical bends ..... No

The unit of measurement shall be the number of vertical bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of vertical bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the vertical bends installed under the Contract.

Item **Unit**

Supply and deliver internal bends ..... No

The unit of measurement shall be the number of internal bends supplied and delivered. Separate items shall be scheduled to include for each size of internal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete internal bends.

Item **Unit**

Install internal bends ..... No

The unit of measurement shall be the number of internal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of internal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the internal bends installed under the Contract.

Item **Unit**

Supply and deliver external bends ..... No

The unit of measurement shall be the number of external bends supplied and delivered. Separate

items shall be scheduled to include for each size of external bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete external bends.

Item **Unit**

Install external bends ..... No

The unit of measurement shall be the number of external bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of external bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the external bends installed under the Contract.

Item **Unit**

Supply and deliver Tee-pieces ..... No

The unit of measurement shall be the number of Tee-pieces supplied and delivered. Separate items shall be scheduled to include for each size of Tee-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete Tee-pieces.

Item **Unit**

Install Tee-pieces ..... No

The unit of measurement shall be the number of Tee-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of Tee-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the Tee-pieces installed under the Contract.

Item **Unit**

Supply and deliver cross-pieces ..... No

The unit of measurement shall be the number of cross-pieces supplied and delivered. Separate items shall be scheduled to include for each size of cross-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cross-pieces.

Item **Unit**

Install deliver cross-pieces..... No

The unit of measurement shall be the number of cross-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cross-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cross-pieces installed under the Contract.

Item **Unit**

Supply and deliver reducers (transition-pieces) ..... No

The unit of measurement shall be the number of transition pieces supplied and delivered. Separate items shall be scheduled to include for each size of transition-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete transition-pieces.

Item Unit

Install reducers (transition-pieces)..... No

The unit of measurement shall be the number of transition-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of transition-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the transition-pieces installed under the Contract.

Item **Unit**

Supply and deliver cable ladder support struts material **m**

The unit of measurement shall be per linear meter of material supplied and delivered. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder support struts supplied and delivered under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the cable ladder support struts material.

Item **Unit**

Install cable ladder support struts **m**

The unit of measurement shall be per linear meter of material supplied and installed. Separate items will be scheduled in the Schedule of Quantities differentiating each cable ladder support struts installed under the Contract.

The tendered rates shall include for all labour, handling, cutting, welding, painting, drilling and mounting, etc., for the complete installation and inspection of the cable ladders support struts installed under the Contract.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E04 : ELECTRICAL LOW VOLTAGE DISTRIBUTION BOARDS AND MOTOR CONTROL CENTRES

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 6

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E04 : Electrical Low Voltage Distribution Boards and Motor Control Centres**

JW Reference: **BWW523C**

Document Ref. No: **E04**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
6	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
5	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
4	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2011-08-30		Omit Fifa Logo
2	2010-05-30		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E04: ELECTRICAL LOW VOLTAGE DISTRIBUTION BOARDS AND MOTOR CONTROL CENTRES

CONTENTS

E04.1 INTRODUCTION....4

E04.2 SCOPE....4
E04.2.1 General....4
E04.2.2 Work to be Included....4

E04.3 STANDARDS....4
E04.3.1 Particular specifications to read in conjunction with this specification....6
E04.3.2 Mandatory Requirements....6

E04.4 SYSTEM DETAIL....6

E04.5 GENERAL REQUIREMENTS....6
E04.5.1 Manufacturing and Construction Details....6
E04.5.2 Electrical Details....11
E04.5.3 Mounting of Equipment....17

E04.6 MOTOR CONTROL CENTRE....18
E04.6.1 MCC Buckets....19
E04.6.2 Busbars....19
E04.6.3 Earth bar....19
E04.6.4 Power wiring....19
E04.6.5 Circuit Breakers....19
E04.6.6 Instruments and Meters....19

E04.7 MAIN DISTRIBUTION BOARD....20
E04.7.1 Busbars....20
E04.7.2 Earth bar....20
E04.7.3 Power wiring....20
E04.7.4 Circuit Breakers....20
E04.7.5 Instruments and Meters....20

E04.8 AUXILIARY DISTRIBUTION BOARD....20
E04.8.1 Busbars....20
E04.8.2 Earth bar....21
E04.8.3 Power wiring....21
E04.8.4 Circuit Breakers....21
E04.8.5 Instruments and Meters....21

E04.9 FLUSH MOUNTED DISTRIBUTION BOARD....21
E04.9.1 Internal for of Separation....21
E04.9.2 Bonding Tray....21
E04.9.3 Expanded Metal....21
E04.9.4 Knock-Outs....22
E04.9.5 Architrave Frame....22
E04.9.6 Extension Frames....22
E04.9.7 Chassis....22
E04.9.8 Panel (Faceplate)....22
E04.9.9 Fixing of Panels....22
E04.9.10 Panel Handles....23
E04.9.11 Hinged Panels....23

E04.10 SURFACE MOUNTED DISTRIBUTION BOARD....23
E04.10.1 Internal for of Separation....23
E04.10.2 Switchboard Tray....23
E04.10.3 Construction....23

E04.11 LV KIOSKS (SWITCH CUBICLES)....23

E04.11.1 Framework....23
E04.11.2 Ventilation....24
E04.11.3 Doors....24
E04.11.4 Warning Sign....24
E04.11.5 Base....24

E04.12 STANDBY SUPPLIES....24

E04.13 ELECTRICAL SUBSTATION FIRE PROTECTION SYSTEM....24
E04.13.1 Fire Detection System....25
E04.13.2 Fire Extinguishing System....25
E04.13.3 Other measures....25
E04.13.4 System Maintenance....26

E04.14 QA REQUIREMENTS....26

E04.15 DRAWINGS AND DATA....27

E04.16 PAINTING AND PROTECTIVE COATING....28
E04.16.1 Powder Coating Systems....28
E04.16.2 Epoxy Powder Coat Products....28
E04.16.3 General....28

E04.17 PERFORMANCE AND GUARANTEE....29

E04.18 INSPECTION AND TESTING....29
E04.18.1 Factory Acceptance Test....29
E04.18.2 Site Acceptance Test and Commissioning....31

E04.19 MEASUREMENT AND PAYMENT....33

E04.1 INTRODUCTION

This specification is for the supply of low voltage (400V) distribution switchboards.

E04.2 SCOPE

E04.2.1 General

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, testing and inspection at works, delivery to site, off-loading and rectification of defects developing during the warranty period for equipment as specified below.

E04.2.2 Work to be Included

The work includes, but shall not be limited to the items listed below.-

(a) All work in E04.2.1 above.

(b) Documentation, as called for in the vendor QA and document requirement list and drawings and data.

(c) The supply of one complete set of any special tools required per switchboard that will be required for operation or maintenance purposes, including three spare sets of each type of fuse.

(d) Recommended spares for one year's operating period and the prices of it.

(e) Technical assistance if requested during checking for operational readiness.

E04.3 STANDARDS

In general, work and materials shall be in accordance with the latest practice and in particular in accordance with the latest revision of the following specifications, and any amendments thereto, the SANS specification taking precedence:

(a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations

(b) SANS 60439-1 : Low-voltage switchgear and controlgear assemblies Part 1: Type-tested and partially type-tested assemblies

(c) SANS 60439-2 : Low-voltage switchgear and controlgear assemblies Part 2: Particular requirements for busbar trunking systems (busways)

(d) SANS 60439-3 : Low-voltage switchgear and controlgear assemblies Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards

(e) SANS 1973-1 : Low-voltage switchgear and controlgear Assemblies Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA

(f) SANS 60947-1 : Low-voltage Switchgear and Control gear Part 1: General rules

(g) SANS 60947-2 : Low-voltage Switchgear and Control gear Part 2: Circuit-breakers

(h) SANS 60947-3 : Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units

(i) SANS 60947-4.1 : Low-voltage Switchgear and Control gear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters

(j) SANS 60947-4.2 : Low-voltage Switchgear and Control gear Part 4-2: Contactors and motor-starters - AC semiconductor motor controllers and starters

(k) SANS 60947-4-3 : Low-voltage Switchgear and Control gear Part 4-3: Contactors and motor-starters - AC semiconductor controllers and contactors

			for non-motor loads
(l)	SANS 60947-5-1	:	Low-voltage Switchgear and Control gear Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices
(m)	SANS 62262	:	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
(n)	SANS 60529	:	Degrees of protection provided by enclosures (IP code)
(o)	IEC 60228	:	Conductors of insulated cables
(p)	BSS 3858	:	Binding and identification sleeves for use on electric cables and wires
(q)	SANS 1507-1	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1: General
(r)	SANS 1507-2	:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 2: Wiring cables
(s)	SANS 1574-1	:	Electric Cables – Flexible Cords and Flexible Cables Part 1: General
(t)	SANS 1574-3	:	Electric Cables – Flexible Cords and Flexible Cables Part 3: PVC-insulated cables for industrial use
(u)	SANS 1619	:	Small power distribution units (ready-boards) for single-phase 230 V service connections
(v)	SANS 61643-11	:	Low-voltage surge protective devices Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
(w)	SANS 61643-12	:	Low-voltage surge protective devices Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
(x)	SANS 61238-1	:	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) Part 1: Test methods and requirements
(y)	SANS 60730-2-7	:	Automatic electrical controls for household and similar use Part 2-7: Particular requirements for timers and time switches
(z)	SANS 62053-61	:	Electricity metering equipment (a.c.) - Particular requirements Part 61: Power consumption and voltage requirements)
(aa)	BSS 1322	:	Aminoplastic Moulding Materials
(bb)	SANS 60076-1	:	Power transformers, Part 1: General
(cc)	SANS 1091	:	National colour standard
(dd)	SANS 61869-1	:	Instrument transformers Part 1: General requirements
(ee)	SANS 61869-2	:	Instrument transformers Part 2: Additional requirements for current transformers
(ff)	SANS 61869-3	:	Instrument transformers Part 3: Additional requirements for inductive voltage transformers
(gg)	IEC 60051/BS 89	:	Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for ammeters and voltmeters
(hh)	BS EN 60255	:	Measuring relays and protection equipment. Common requirements
(ii)	SANS 156	:	Moulded-case circuit-breakers
(jj)	SANS 1195	:	Busbars
(kk)	BS159	:	High-voltage busbars and busbar connections

E04.3.1 Particular specifications to read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-
E26: ELECTRICAL COLOUR CODING OF EQUIPMENT
G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
E08: WIRING

E04.3.2 Mandatory Requirements

All equipment and services shall comply with the mandatory requirements of:

(a) Occupational Health and Safety Act 85 of 1993 (as amended).

E04.4 SYSTEM DETAIL

Busbar voltage	400V ±10% as per system voltage on the site
Frequency	50 Hz
Phase rotation	R-Y-B-R
Phases	3Ph+N, with Protective Earth (PE)
Earthing system	TN-S

E04.5 GENERAL REQUIREMENTS

This section will be applicable to the following equipment:

(a) Motor Control Centres (MCC).

(b) Main Distribution Boards (MDB).

(c) Auxiliary Distribution Boards (ADB).

The following is described in separate sections:

(a) Flush Mounted Distribution Boards.

(b) Surface Mounted Distribution Boards

(c) LV Kiosks (Switch Cubicles)

E04.5.1 Manufacturing and Construction Details

E04.5.1.1 General

(a) Electrical panels will be floor standing unless specified differently.

(b) All floor-standing switchboards will be positioned above a cable trench with bottom entry cables.

(c) Electrical switchboards positioned inside Electrical Distribution/MCC rooms shall be manufactured with 2mm thick mild steel.

(d) Electrical switchboards positioned outside Electrical Distribution/MCC rooms shall be manufactured from 2mm thick stainless steel (3CR12) as a minimum. Heaters will be installed in the switchboards to prevent condensation.

(e) In special applications, the Electrical switchboards will be manufactured to the Engineers specification.

(f) All switchboards shall be of ample size to accommodate all the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) circuit breakers of a kind on a switchboard, space for an additional circuit breaker of similar size shall be allowed unless future space requirements are clearly specified.

(g) All specified external dimensions for switchboards shall be strictly adhered to.

(h) The Contractor or Manufacturer shall obtain the opinion of the Engineer before manufacturing any switchboard.

(i) The Contractor shall ascertain the exact position of switchboards and shall arrange timeously for the installation of cable sleeves, openings in the structure, flush draw trays behind switchboards and supports over cable trenches.

(j) In general, flush and surface mounted switchboards shall be mounted 2000mm above finished floor level - measured to the top of the switchboard. The upper ends of switchboards may not be higher than 2100mm above finished floor level.

(k) Unless otherwise agreed or stated in this Specification, all screws, bolts and nuts shall be hexagonal to ISO metric commercial standards and shall be rustproof. Loose ‘bolts and nuts' shall not be used on steelwork. Blind threaded fastening system bushings or equivalent shall be used for thread sizes M5 and above. Studs projecting from the exterior surfaces of the board shall have chrome or cadmium plated dome nuts. Self-tapping screws shall not be utilised for any purpose on any equipment.

(l) The short-circuit current levels as indicated on drawings shall be deemed the maximum fault current occurring at the panel under symmetrical short circuit conditions on the line side of the final limiting device in a circuit. The duration of the maximum short circuit currents shall be deemed a minimum of one second. Evidence (in the form of certificates from testing authorities recognised by Johannesburg Water) of the ability of the 400V switchboards offered to withstand satisfactorily the prospective fault conditions shall be furnished with the tender.

(m) Switchboards shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the operator.

(n) The general structure of the panel shall be designed and fabricated to ensure that no excessive vibration caused by the operation of any component is transmitted to any other components, thereby causing spurious tripping of any device.

(o) Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.

(p) Bolts shall be of the correct size for the holes provided and shall be fitted with matching sizes of washers and lock washers. Where removable covers are provided with bolt fastening, the nuts shall be either welded in position or securely fixed by means of a mechanical fixing device. Self-tapping screws, captive head nuts or cage nuts are not acceptable.

E04.5.1.2 Panel Subdivision

(a) The Electrical panel will be constructed as one or more fully interchangeable modular, rigid, free standing columns, bolted together to form an extensible, composite, vermin proof unit of uniform appearance.

(b) Panels shall be designed to permit the addition of identical columns.

(c) Columns widths will be 600, 700, 800, 900 or 1000 mm for design flexibility. Columns will be 600 or 800mm deep. Increase in depth of certain sections of panels for high current ratings shall be subject to the Engineer's approval.

(d) The overall height of the column may not be more than 2300mm.

(e) Each column shall be divided horizontally into buckets.

(f) Panels will be split into transportable section with lengths not exceeding 3000mm for ease of transportation.

(g) A channel iron frame (minimum 100mm x 50mm) shall be provided under each panel

section of transportable length, which shall be so constructed that it can be used for lifting the transportable section without distortion taking place.

(h) All panel section of transportable length shall be fitted with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.

E04.5.1.3 Internal Form of Separation

(a) The minimum internal Forms of Separation for any Electrical switchboards shall be Form 3b, as described below:

i. Separation of busbars from all functional units;

ii. Separation of all functional units from one another;

iii. Separation of terminals for external conductors from the functional units, but not from those of other functional units;

iv. The power cable connections are disposed in the same compartment;

v. Maintenance services require extra care, as placed in the same compartment the connections of other units might be powered;

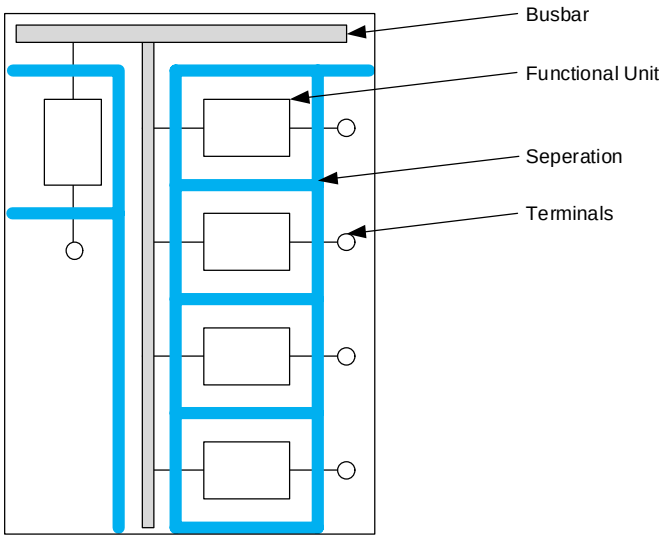


Figure 1: Form 3B

E04.5.1.4 Buckets

(a) Buckets will be equipped and wired as per the drawings issued by the Engineer.

(b) The buckets will be sized to accommodate all components with ease.

(c) Buckets will be fixed pattern with components permanently mounted to the chassis plate of the bucket.

(d) All bucket design and construction shall be based on natural cooling by convection or radiation. Attention shall be given to ventilation to prevent the accumulation of heat in buckets where power electronic drives (soft starters and VSD's) or other heat generating equipment (i.e. control transformers) are contained. Extraction ventilation fans should be installed in these cases to remove heat from the cubicle. The filtered extraction fan should be placed as high as possible in the compartment door with a filtered air inlet opening as low as possible in the compartment door. The fan and opening must be sized to ensure all generated heat is extracted from the bucket. Natural convection cooling will not be accepted.

(e) Spare buckets shall be equipped generally as detailed on the drawings issued by the

Engineer, and shall include all circuit breakers, busbars, wiring, instruments, etc., with the exception that, in the case of withdrawable circuit breakers, only the breaker cradle shall be furnished.

E04.5.1.5 Doors

(a) Buckets shall have doors suitably constructed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.

(b) Doors shall be fitted with robust steel or brass hinges with at least two 6mm square recessed quick close/open latches. Hinges shall be provided at 500mm intervals per door with a minimum of two hinges per door. Each door shall be fitted with an equal number of hinges and latches. At least one of these latches shall be lockable with a padlock.

(c) Doors and covers shall be provided with a high-density neoprene gasket to form a firm seal. The neoprene seal shall be a nominal 5mm thick compressed to 3mm on closing of the door. The entire switchboard shall be effectively dust and splash proof to IP 54.

(d) All hinged doors shall be fitted with a robust mechanism to latch and hold the door in the wide-open position, to minimise inadvertent contact with live parts during maintenance operations.

(e) All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.

(f) Doors should be the same width as the MCC column. A single door shall not exceed the width of 800mm. Where the column width exceeds 800mm, two doors must be installed.

(g) The Bucket door shall be interlocked with the circuit breakers to prevent opening of the door when the circuit breaker is in the "ON" position. A non-apparent door interlock defeat shall be provided for the opening of the door with the circuit breaker in the “ON” position for testing and maintenance. In addition, there shall be provision for attaching a padlock to the operating handle in the “OFF” position that prevent the circuit breaker from being operated. Should more than one padlock be fitted, a safety lockout hasp must be used.

(h) All access doors are to be effectively and permanently earthed to the main panel enclosure, by means of a suitable braided copper earth strap, not less than 6mm^2, crimped with properly sized lugs and bolted at each end to the door and enclosure.

(i) All equipment mounted on bucket door will be flush mounted.

E04.5.1.6 Busbar Compartments

(a) The Busbar compartment shall contain the three phases and the neutral busbars, duly marked L1, L2, L3 and N or identifiable by colour coding Red, White, Blue and Black.

(b) The protective earth busbar shall be located in a separate compartment, and shall be duly marked PE.

(c) Provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions. The busbars shall allow for expansion on both the left and right-hand side.

(d) The busbar compartment shall have bolted covers on the front of the panel for access to the busbars, insulators and joints. Removable covers shall be provided with captive screws.

(e) All busbars and droppers shall be securely supported by heavy, high di-electric, non-hygroscopic material with bracing to withstand stresses due to short circuits of one second duration and at least equal to the interrupting rating of the circuit breaker protecting the busbars.

(f) Busbar standoff insulators and support will be injection moulded (Polyamide 66 fibreglass reinforced (30%) (Halogen free)). Threaded inserts will be galvanized steel.

(g) The Busbar shall be supported by insulators made of flameproof and leakage-proof

material. Busbars, insulators and supports shall be braced to withstand the mechanical and thermal effects of fault currents.

(h) Busbar insulators shall be mounted in such a way that they can be easily removed and replaced.

(i) In addition to any support/bracing required by the electrical conditions, the busbars shall also have sufficient support to prevent stresses being transmitted to the circuit breakers or any components by cable terminations. Particular attention must be paid to the termination arrangements of any multiple incoming three-core cables to ensure adequate glanding space.

(j) The following minimum air clearances shall be observed for busbars and other current carrying or live parts:

i. Phase – Earth : 30mm

ii. Phase – Phase : 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed In addition, all busbar work (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. GPO-3 (Glass Polymer laminate) insulation shall be used wherever possible. GPO-3 is constructed with fiberglass-reinforced thermoset polyesters. It must feature a combination of beneficial electrical and mechanical properties. These attributes include Dielectric strength, flame resistance, arc and track resistance, high-flex strength and high-impact strength. They maintain stability, will not melt under heat and have excellent overall electrical properties.

(k) The busbar compartment shall be constructed to ensure that fire or other faults cannot spread between the various sections. All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.

(l) The busbar compartment must have suitable sealing arrangement at each end as well as between the busbar compartment and buckets.

E04.5.1.7 Cable termination points

(a) Suitable termination points shall be provided to enable any multiple three-core cables to be terminated without cross-overs of different phases and with minimum lengths of cable "tails".

(b) All cable termination points and associated connections shall be suitably braced to withstand the available fault currents without damage. If necessary cable support clamps shall be provided for the individual cable tails after the cable gland.

E04.5.1.8 Cable Gland Plates

(a) Sectionalised removable gland plates shall be fitted and shall be fixed by means of captive nuts or screws and so located that ample space is available for the satisfactory entry and termination of cables

(b) Cable entry shall be at the bottom of the board.

(c) All gland plates are to be connected to the main panel earth bar via suitably sized copper conductors and unused sections shall be left blank.

(d) Gland plates for three-core cable of cross-sectional area 70mm^2 and above shall be minimum 5mm thickness.

(e) Mild steel gland plates shall be galvanised.

(f) Where single core cables are used, gland plates are to be of non-magnetic material or slit to mitigate effect of eddy currents.

(g) The cable gland compartments shall have removable covers attached with standard 6mm

square recessed quick close/open latches.

E04.5.1.9 Labelling and markings

(a) The panel shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchgear.

(b) Each buckets shall be labelled on the left top door corner with the reference letter(s) of that compartment, using durable designation label with 30mm high black letters on a white background. The labels shall have two designation letters, the first referring the column, numbered from A, left to right and the second referring to the bucket, numbered from 1 top to bottom.

(c) All buckets shall be clearly labelled with suitable inscriptions indicating their function. All labels shall have black characters at least 6mm high on white background.

(d) Incomers shall be labelled "Incomer from ……....” as indicated on the drawings issued by the Engineer, using engraved black characters at least 6mm high on white background.

(e) Standby bus coupler (where applicable) shall be labelled "Standby Bus Coupler", using engraved black characters at least 6mm high on white background.

(f) All removable covers protecting live equipment shall be fitted with warning labels as well as ID tags to ensure the covers are replaced in the original position after removal. Warning labels shall be engraved white characters 6mm high on a red background.

(g) All electrical components/equipment shall be labelled (with designations corresponding to those of the Engineer’s schematic diagrams) to facilitate recognition.

(h) The labels for equipment mounted on doors shall be identified with white trifoliate labels having black lettering engraved on them, with a maximum height of 3mm letters.

(i) The equipment labels shall be secured by means of high quality double-sided tape.

(j) The labels for all equipment, installed behind panels, shall be fixed to the chassis close to the equipment.

(k) If this equipment is positioned too close to each other to accommodate descriptive engraved labels, the equipment may be identified by a code or number label, which shall be fixed close to the equipment. The code or number shall be identified on a legend board, which shall be installed on the switchboard behind a protective cover.

(l) The types of labels for equipment behind the doors or covers shall be subject to the Engineer's approval.

(m) Danger labels shall be white lettering 6mm high engraved on a red background.

(n) All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.

(o) Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must be met.

E04.5.1.10 Insulation Materials

(a) Any insulation, filling putty, etc., used shall be selected such that it can withstand without harmful effect (mechanically or electrically), all temperatures encountered within the MCC.

E04.5.2 Electrical Details

E04.5.2.1 Busbars and Connections

(a) Busbars and connections shall generally comply with SANS 1195 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copper work shall be made of hard drawn high conductivity copper of constant cross-section throughout

their lengths with a maximum design current density of 1,66A/mm².

(b) The Phase and Neutral busbars shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole width of the panel.

(c) Busbar droppers shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole length of the dropper. The use of flexible conductors as droppers from the main busbars to circuit breakers shall not be permitted.

(d) All busbar joints shall be silver plated or tinplated. High pressure bolted lap joints shall be used and all bolts shall be of the high tensile type.

(e) All fixed busbar joints (separation links) between adjacent sections shall be maintenance-free.

E04.5.2.2 Earth Bar

(a) A protective earth bar shall extend the whole length of each Electrical panel and shall be duly marked PE. The earth bar shall at least, be bolted to the switchgear housing at each column.

(b) Stranded clear insulated aluminium earth wire (equal to 70mm^2 copper wire) with crimp type terminals shall be provided at both ends of the protective earth bar for connection to the substation earth bar/earthing system.

E04.5.2.3 Control Wiring

(a) Each Electrical panel shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transportation.

(b) Control and instrumentation wiring shall be silicone insulated throughout and of flexible, stranded, annealed, untinned copper construction. All wiring shall comply with the table below. Conductors shall comply with SANS 1411, Part 1, Table 4, Class 5.

CT Wiring	-	2.5mm^2 phase coloured, common return black insulated, earth green/yellow
General Control Wiring	-	(AC) 1.0mm^2 grey
	-	(DC) 2.5mm^2 (positive – red, negative – black)
Control Neutral	-	(AC) 1.0mm^2 (same size as phase wiring) – black
LED's and PLC Inputs	-	(AC) 0.75mm^2 grey
	-	(DC) 0.75mm^2 (positive – red, negative – black)

(c) Notwithstanding the above-mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions.

(d) All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs on screw-type terminals. Terminals of the pressure pad type are not accepted. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Parts 1 and 3.

(e) Wiring shall be run in plastic trunking. Only where a space problem exists will loomed wiring be acceptable.

Note: Stick-on harness holders are not acceptable.

(f) Conductors passing through holes in compartments shall be protected by means of neoprene grommets. Bevelling of sheet steel will not be accepted as a substitute.

(g) Conductors shall be general-purpose 600/1000V grade PVC-insulated copper wire to SANS 1507 and SANS 1574. Aluminium conductors are not acceptable.

(h) Single or solid conductor wire shall not be used.

(i) Joints or splices in any wiring are not acceptable.

(j) Panel and equipment terminals, labels, etc., shall be accessible after the wiring has been completed.

(k) Connections to equipment on swing doors shall be arranged to give a twisting motion and not a bending motion to the conductor.

(l) Single pole and double pole moulded-case circuit breakers shall be wired in a way that the supply to the switchboard is equally balanced.

(m) Stripping of insulation shall not result in damage to the conductors. The stripping tools used shall be of the type, which permits the length of strip to be pre-set. Control wiring shall be terminated with pre-insulated, crimped or compression type lugs. Crimping tools shall be of the type, which will not release the termination during normal operation until the conductor crimp has been correctly formed. Any damaged wiring will be rejected.

(n) Lugs shall be of the hooked blade type when used in conjunction with screw clamp spring loaded insertion type terminals, ring tongue type when used with stud or direct screw mounted connections and wire pin when used with pinch screw type connections such as indicating lamp fittings.

(o) Not more than two conductors shall be connected to any side of a terminal.

(p) Each terminal strip shall be provided with not less than 10% spare terminals, with a minimum of two, unless otherwise approved.

E04.5.2.4 Power Wiring and Cable Terminations

(a) Power wiring on the "live" side of the circuit breakers (from the busbar dropper to the circuit breaker terminals) shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective circuit breaker and shall be a flexible copper conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the busbar droppers and the circuit breaker. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.

(b) Power wiring on the "load" side of the circuit breaker terminals to cable termination terminal shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective breaker and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the circuit breaker and the cable termination terminal. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.

(c) Terminals that are on the live side of fuses and isolating switches shall be completely shrouded to prevent accidental contact.

(d) Power circuit wiring and connections in a switchboard shall be rated to the full frame size rating of the associated equipment, i.e. fused switch, contactor, circuit breaker, etc., and not to the circuit or fuse rating.

(e) Power wires shall bear the colour along their entire length of the phase to which they are connected.

(f) Neutral connections shall have the same rating as the phase connections unless otherwise

approved.

(g) Power wiring terminations shall use an appropriate crimped accessory (the pressed tubular type of accessories). Stamped, folded, split-barrel type accessories are not acceptable.

(h) Terminations for power wiring and cabling shall be provided with pressure type clamping connections or bolted connections capable of accepting crimped or compression type lugs on conductors.

(i) In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm² in size.

(j) Cables shall be made off directly onto circuit breakers, switches, contractors, thermal-overloads, etc. Terminals or solid copper terminating conductors shall be provided where necessary. Provision shall be made for bracing and fixing of the cable leads to prevent vibration.

(k) A predrilled solid copper bar shall be provided for terminating all external power cables above 70mm, or where three or more cables in parallel are specified. The arrangement shall be suitable for accepting cable lugs of conductors up to 630mm².

E04.5.2.5 Wire Numbering

(a) Each end of every wire shall be marked with a wire number by means of plastic cable ferrules (black lettering on a white or yellow base).

(b) All wires shall be identified on both ends with a wire marker. The wire marker shall consist of a transparent flexible tube that slides over the wire with a wire identification label (black letters on a rigid white PVC tag) which slides into a label pocket on the tube. The tube must be correctly sized for the wire diameter.

(c) Split or open type marking ferrules shall not be used.

(d) Cable/wire marking ferrules shall correlate to the appropriate schematic or wiring diagrams.

(e) For all control wires without lug terminations, the numbered ferrule must not fall off when disconnecting the wire and in this regard, the use of one strand of wire to retain the ferrule is acceptable.

(f) All cables shall be identified on both ends with a cable marker. The cable marker shall consist of printed stainless steel band fixed to the cable with stainless steel strapping.

E04.5.2.6 Terminals and Connections

(a) All terminals will be of the screw-type. Terminals of the pressure pad type are not accepted Minimum rating for terminal blocks shall be 40A. Terminal strips/blocks shall be marked with designations corresponding with the suppliers/buyers drawings. Generally, terminal numbers shall be the same as the relevant wire number. No more than two wires may be connected to any one side of a terminal. Ten percent (10%) additional spare terminals shall be furnished.

(b) Terminals are to be provided for all door-mounted components, diodes, etc.

(c) Power connections on any equipment shall not use "Philips/Star" type screw/socket heads. Hexagon socket head cap screws (Allen type socket heads) are preferred.

(d) Where a large number of control terminals are mounted in close proximity, the terminals shall be in vertical rows with a minimum of 125mm below rows. Spare terminals shall be mounted at the bottom of the row unless the cabling drawing shows otherwise.

(e) Terminals shall be provided for all cores of external control cable as indicated on the drawings whether internally connected or not.

E04.5.2.7 Air Circuit Breakers (ACBs)

(a) ACBs shall be of the withdrawable type with self-aligning disconnecting devices with the disconnecting fingers preferably mounted on the breaker for ease of maintenance. The draw out mechanism shall hold the circuit breaker rigidly in the fully connected, test and fully disconnected positions.

(b) Safety shutters shall be provided to shield the fixed part automatically when the draw out parts removed preventing access to the conductors (main and auxiliary circuits). These shutters shall be clearly labelled indicating busbar and cable sections and in addition "live" section shall be labelled "400V – LIVE". ACBs shall be equipped with inter-phase barriers.

(c) Each Incoming ACB from a transformer and each Bus Section ACB shall be equipped with a protection unit incorporating:

i. Overload protection (IDMT)

ii. Thermal overload protection

iii. Instantaneous short-circuit protection

All protection devices will be delivered with protection settings adjusted to the minimum level. The protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.

(d) The Contractor shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and downstream protective devices.

(e) Current and time delay set points on ACBs shall be accessible from the front of the ACB without removing the ACB from its cradle and shall only be adjustable when the cubicle door is open.

(f) Interlocks shall be provided to ensure the following:

i. That the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open;

ii. That the compartment doors cannot be opened should any accessible portion of the ACB frame be energised;

iii. That the ACB cannot be closed unless in the fully connected, test or fully disconnected positions.

(g) Mechanical restrictions shall be provided to inhibit mismatch of ACBs of different ratings.

(h) Provision shall be made for the padlocking of any ACB in any one of the fully connected, test or fully open positions. In addition, all ACBs shall have padlocking facility to prevent the close push button being operated when padlocked.

(i) ACBs employed as incomers and bus-section switches shall incorporate captive key interlocks to prevent paralleling of incoming supplies. Locks with captive keys must be built into the ACB's to prevent both Incomers and the Bus-coupler circuit breakers in the "ON" position at the same time. Padlocks will not be accepted for this application.

(j) The ACBs supplied shall be three pole, magnetic operated. The mechanism shall be of the stored energy type having hand charged spring with mechanical and electrical releases for closing.

E04.5.2.8 Moulded Case Circuit Breakers (MCCBs)

(a) MCCBs shall be of the manually operated type with thermal and instantaneous magnetic protection. Trip functions shall be resettable via the MCCB switching handle.

(b) Each MCCB shall be fitted with a vari-depth operating handle.

(c) Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on both sides of the MCCB.

(d) The thermal trip elements of each MCCB shall be calibrated for the maximum ambient

temperature at 40°C.

(e) Current ratings of MCCBs shall be detailed in the Single Line Diagram drawings.

(f) MCCBs shall be selected according to rating and the fault level as specified by the Engineer.

(g) The name of the MCCB manufacturer shall be furnished by the tenderer at tender stage.

(h) Each MCCB shall be provided with suitable insulation between the terminals of the MCCB and the back plate/chassis onto which the MCCB is mounted, such that any loose nut, screw, etc., which may fall between the MCCB terminals and back plate cannot cause a short circuit.

(i) Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or a mechanical interlock.

(j) All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit.

(k) Outgoing circuits rated 125A and above shall have IDMT 375 mA earth leakage units EPC type Elsec T. Outgoing circuits rated 100A and below shall have instantaneous 250 mA earth leakage units - EPC type Elsec – X. All earth leakages must be of the manual reset type.

(l) All circuit breakers, except bus couplers, shall be connected with the switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".

(m) The incoming terminals/shutters of all 400V circuit breakers shall be effectively shrouded and marked "400V LIVE" with white characters on a red ground.

E04.5.2.9 Miniature circuit breakers (MCBs)

(a) Miniature circuit breakers (MCBs) shall be confined to auxiliary circuits such as control and indication in which the prospective short-circuit current will not exceed 5kA (3ph at 440Vac), or 7.5kA (1p at 24Vdc). They shall be of the thermal and magnetic trip free type. Where the prospective short-circuit current exceeds the above values, cascaded circuit breakers should be used. All cascaded circuits must be marked with the wording "Warning: This is a cascaded system. Never replace any circuit breaker in the system with another circuit breaker that is not identical in manufacturer, type and rating."

(b) Auxiliary contacts on MCBs

i. Provide the position (open/closed/tripped) remote indication functions of the associated MCB.

ii. Clip on (no tool required) to the left-hand side of the MCB. The type that connects to the MCB operating lever is preferred.

iii. Shall be of good quality and will not interfere with the operation or tripping of the MCB.

E04.5.2.10 Surge Arrestors

(a) All Electrical switchboards shall have a surge arrestor fitted to each phase on the incoming circuit breaker. The surge arrestors shall be fitted to the LIVE side of the circuit breaker.

E04.5.2.11 Instruments and Meters

(a) Incoming CBs shall be equipped with the following as a minimum requirement:

i. A single 96mm x 96mm 5A secondary, combined maximum demand and instantaneous ammeter. The maximum demand portion shall have a thermal movement with 15-minute time lag and drag pointer having a reset facility. It shall have a built-in saturation transformer for increased overload capacity to 90 times

rated current for one second;

ii. A 96mm x 96mm voltmeter connected to measure phase-to-phase voltage and phase to neutral voltage via a multi-position selector switch and a set of fuses suitably rated for voltage and short circuit current;

E04.5.2.12 Current Transformers

(a) All current transformers shall conform to SANS 61869-2. For protection purposes, class 10P CT's are to be used and for indicating purposes class 1 CT's are to be used and for metering purposes class 0.5 CT's are to be used. In general, current transformer mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment.

E04.5.2.13 Fuses

(a) Fuse protection shall be used in cases were capacitive loads are switched i.e. Power factor correction or static capacitors panels.

(b) Fuses shall not be used for purposes other than voltmeter or kWh meter protection, unless specifically authorised. All short circuit protection shall be provided by means of circuit breakers and fast blow fuses for protecting the incoming side of the devices. In cases where the fault current level is excessively high, HRC fuses in conjunction with CB's should be considered to reduce the fault level and afford better protection for electrical personnel.

E04.5.2.14 Limit Switches

(a) Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures.

(b) Cables shall be equipped with a strain-relief device and safely cast into the enclosure. Switches shall have bottom, side or lateral cable outlets as per the requirement of the application. The integrated basic switch shall have a single-pole changeover contact with a high switching accuracy and a precise repeatability of the switching point.

(c) It shall have high vibration resistance and long mechanical life. It shall have a high protection class that would allow the switch to be used in all processes of Johannesburg Water wastewater treatment plants.

E04.5.3 Mounting of Equipment

E04.5.3.1 Clearance and Access

(a) A minimum clearance of 50mm shall be maintained between items of equipment and the side of the compartment.

(b) Where extra equipment is specified after the design has been finalised, this clearance requirement may be altered subject to the Engineer's approval.

(c) No piece of equipment shall be mounted in any position where it is not visible and accessible to a viewer looking into the compartment through the door opening.

E04.5.3.2 Mounting of Circuit Breakers

(a) All moulded case circuit breakers shall be flush mounted with only toggles protruding.

(b) Miniature circuit breakers may be installed in clip-in trays mounted on the frame.

(c) Special provision shall be made for large main switches.

(d) Circuit breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

E04.5.3.3 Mounting of Contactors

(a) Contactors shall only protrude through the panel in special cases. Plastic covers or other coverings will not be required.

E04.5.3.4 Instrumentation

(a) All metering instruments shall be mounted flush in the front panel unless otherwise specified.

(b) In certain instances it may be required that instruments be mounted flush in the door. In these instances, the back of metres shall be covered by removable covers of isolating material fixed to the door to protect the terminals of instruments and to prevent accidental contact.

(c) Equipment mounted normally on the surface, e.g. time switches and relays shall be mounted behind the front panel. In these cases, hinged access panels shall be provided in the front panel.

E04.5.3.5 Fuse-Links and Carriers

(a) Fuses shall be of the high rupturing capacity type and shall be mounted on insulated draw-out carriers, which shall hold the fuses positively and remain firmly fixed after withdrawal. In all cases, the top terminal shall be the live terminal. This applies also for MCB's.

(b) DC circuits shall have fuses in the positive and negative leads.

(c) Fuses shall be so positioned that they are readily accessible to a person standing on the floor.

(d) Fuses for instrumentation shall be mounted on the outside of the compartment door adjacent to or below the instrument.

(e) Fuses shall be provided with labels giving their rating and duty.

(f) Solid link holders shall be coloured white.

(g) One spare fuse of each type and size used in each board shall be fitted on clip holders on the inside of the front panel.

E04.5.3.6 Control Equipment

(a) All equipment performing control functions, e.g. control relays, transducers, and time relays not requiring adjustment, shall be mounted behind the front panel.

E04.5.3.7 Current Transformers

(a) Current transformers shall be accessible and easily removable.

(b) Secondary windings of current transformers shall be earthed at one point only. Each group of current transformers, i.e. protection, metering, etc., shall be earthed directly to the protective conductor (earth bar).

(c) Current transformers shall be naturally air-cooled, and shall be able to withstand the maximum fault current for the duration of time taken by the functional unit to clear, with protective devices set at the maximum time delay settings.

E04.6 MOTOR CONTROL CENTRE

A Motor Control Centre (MCC) is an assembly of one or more enclosed sections having a common

power bus and principally containing motor control units that serves to govern in some predetermined manner the performance of an electric motor. Motor control centres are in modern practice a factory assembly of several motor starters. A motor control centre can include variable frequency drives, programmable controllers, metering apparatus etc. Motor Control Centre is used for controlling of various motors of a particular plant.

E04.6.1 MCC Buckets

(a) The following types of motor starters will be used:

i. Direct-on-line (DOL) type motor starting;

ii. Star/Delta (S/D) type motor starting;

iii. Forward/Reverse type motor starting;

iv. Soft starting (SS) type motor starting;

v. Variable Speed Drive (VSD) type motor starting.

(b) The main contactors on Star/Delta and Forward/Reverse type starters will be mechanically interlocked. The type of motor starting required shall be project specific and shall be indicated in the MCC schedule/s to be issued by the Engineer.

(c) All the protection devices, i.e. overloads, circuit breakers, motor thermistors, motor heaters, gearbox oil flow switches etc. on mechanical equipment shall be hard wired onto the individual motor starter circuits.

(d) Only one motor will be controlled from any MCC bucket.

E04.6.2 Busbars

(a) Main busbars in MCCs shall be rated for 2000 amps as a minimum.

(b) Busbar droppers in MCCs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.6.3 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.6.4 Power wiring

(a) The minimum MCC power wiring size shall be 25mm².

E04.6.5 Circuit Breakers

(a) Air circuit breaker (ACBs) will be used for Incomer circuit breakers on MCCs.

(b) Bus coupler circuit breakers on MCCs will use an air circuit breaker (ACBs).

(c) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MCCs up to a maximum rating of 800 amps.

E04.6.6 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Each bucket shall be equipped with a suitably sized 5A current transformer (CT) operated

96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.7 MAIN DISTRIBUTION BOARD

A Main Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a distribution transformer and includes feeder circuit breakers and protection devices to the consumers.

E04.7.1 Busbars

(a) Main busbars in MDBs shall be rated for 2000 amps as a minimum.

(b) Busbar droppers in MDBs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.7.2 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.7.3 Power wiring

(a) The minimum MDB power wiring size shall be 25mm².

E04.7.4 Circuit Breakers

(a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on MDBs.

(b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MDBs up to a maximum rating of 800 amps.

E04.7.5 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Feeder CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

E04.8 AUXILIARY DISTRIBUTION BOARD

An Auxiliary Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a Main Distribution Board and includes feeder circuit breakers and protection devices to the consumers.

E04.8.1 Busbars

(a) Main busbars in ADBs shall be rated for 1000 amps as a minimum unless otherwise specified/approved by the engineer.

(b) Busbar droppers in ADBs shall be rated for the maximum possible current (determined by

the breaker frame size) in that section with a minimum rating of 600 amps unless otherwise specified/approved by the engineer.

E04.8.2 Earth bar

(a) The earth bar shall be rectangular, with a minimum cross sectional area of 250mm² (10mm x 25mm) unless otherwise specified/approved by the engineer.

E04.8.3 Power wiring

(a) The minimum ADB power wiring size shall be 16mm² unless otherwise specified/approved by the engineer.

E04.8.4 Circuit Breakers

(a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on ADBs unless otherwise specified/approved by the engineer.

(b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on ADBs up to a maximum rating of 800 amps.

E04.8.5 Instruments and Meters

(a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVAr, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

(b) Feeder CBs shall be equipped with a suitably sized 5A current transformer operated 96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.9 FLUSH MOUNTED DISTRIBUTION BOARD

E04.9.1 Internal for of Separation

(a) The internal for of separation will be specified by the Engineer.

E04.9.2 Bonding Tray

(a) Bonding trays for flush mounted switchboards shall be of rigidly constructed 1,6mm thick galvanised steel, braced and reinforced.

(b) Formed gussets shall be provided at the corners. All the tray joints shall be properly welded or securely bolted with a brass or cadmium plated steel earth connecting stud and nut.

E04.9.3 Expanded Metal

(a) Where switchboards are to be built into 116mm thick walls, expanded metal shall be spot welded to the rear of the bonding trays.

(b) The expanded metal shall protrude at least 150mm on each side to prevent plaster from cracking.

E04.9.4 Knock-Outs

(a) Ample knockouts shall be provided in the top and bottom ends of each switchboard tray to allow for the installation of conduits for the specified and future circuits.

(b) Knockouts shall be allowed for any size of specified conduit.

(c) Provision shall however be made for termination of at least 2 x 25mm diameter conduits at top and 2 x 25mm diameter conduits at the bottom of each tray.

E04.9.5 Architrave Frame

(a) The architrave frame shall be of 2,0mm thick sheet steel with bevelled edges.

(b) The architrave frame shall accommodate the chassis, panels and doors.

(c) The architrave shall overlap the bonding tray by at least 25mm on each side.

(d) The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

E04.9.6 Extension Frames

(a) Semi-flush mounted switchboards shall be equipped with extension frames.

(b) Generally, the frame depths shall be 50mm but may be altered to suit each application.

E04.9.7 Chassis

(a) The chassis for mounting of switchgear and equipment shall be of rigid construction and shall be fixed securely to the architrave frame or bonding tray by means of bolts screwed into tapped holes or bolts and nuts. Self-tapping screws are not acceptable.

(b) The chassis position shall be adjustable in the horizontal plane.

E04.9.8 Panel (Faceplate)

(a) A suitably stiffened panel manufactured of 2,0mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear.

(b) The panels shall have machined punched slots for housing the specified and future switchgear, instruments, fuse holders, isolating switches, indicator lamps, etc. In exceptional cases, contractors will be allowed to protrude through the panel.

(c) Blanking plates shall be provided in positions where future switchgear will be installed.

(d) The distance between the inside of the closed doors and the panels shall be not less than 40mm.

(e) No equipment may be mounted on the panel (faceplate) unless it is permanently hinged to the switchboard frame.

E04.9.9 Fixing of Panels

(a) The panel for each switchboard shall be secured to the architrave frame by means of captive fasteners. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws or dome nuts will not be allowed.

(b) Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

E04.9.10 Panel Handles

(a) Two chromium plated handles shall be provided on each front cover.

(b) The handles shall be mounted at the top and bottom of each panel.

E04.9.11 Hinged Panels

(a) Where hinged panels are specified, the hinges shall be fixed to the architrave frame and the panel shall be secured by means of studs and hexagonal chromium plated nuts or by means of a suitable lock or latch, which can be operated with a screwdriver.

(b) The panel shall be removable when it is in the open position.

E04.10 SURFACE MOUNTED DISTRIBUTION BOARD

This section refers to surface mounted sub-switchboards and not to floor standing main switchboards in substations or sub-main switchboards.

E04.10.1 Internal for of Separation

(a) The internal for of separation will be specified by the Engineer.

E04.10.2 Switchboard Tray

(a) Surface mounted switchboards shall be equipped with a 1,6mm sheet steel reinforced tray.

(b) Securing lugs shall be provided to fix the tray to walls or any other structure.

(c) A solid brass or cadmium plated steel earth connection stud and nut shall be provided.

E04.10.3 Construction

(a) All joints shall be welded or securely bolted.

(b) The tray shall be square and neatly finished without protrusions.

(c) The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors.

(d) The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards.

(e) The doors shall be hinged and shall fit flush in the frame in the closed position.

(f) Knockouts shall not be provided unless specifically called for.

E04.11 LV KIOSKS (SWITCH CUBICLES)

LV kiosks shall be of sufficient size to accommodate all the specified equipment.

E04.11.1 Framework

LV kiosks shall be manufactured of mild steel sheet metal with a minimum thickness of 2mm or cold rolled 3CR12 sheet metal with a minimum thickness of 1,6mm. Fibre re-inforced or other corrosion proof material (e.g. glass fibre) may also be used if adequately reinforced.

E04.11.2 Ventilation

Two ventilation slots or grilles, approximately 150 x 125mm and covered on the inside with copper mesh, shall be provided on opposite sides of the cubicle.

E04.11.3 Doors

Doors shall be provided in the front and back panels and shall swivel through 180º. Rigid padlocks and base plates for security latches shall be provided on the doors. Openings for security latches shall be blanked with chromed brass discs.

E04.11.4 Warning Sign

Warning and danger signs shall be mounted on each door in compliance with the requirements.

E04.11.5 Base

The kiosk shall be mounted on a well-finished concrete base, with minimum height of 150mm above ground level in the case of mild steel and any of the other specified acceptable materials. The kiosk can be made for direct mounting into the ground in which case it shall be equipped with a base, forming part of the structure, for this purpose. The switch cubicle shall protrude at least 10mm past the edges of the base to prevent water collecting on the base.

E04.12 STANDBY SUPPLIES

(a) Where standby power from a diesel-generator set or other source is available and has to be connected to some of the equipment on a panel, the panel shall be divided into electrically separate sections with sheet metal division plates to isolate power and mains power sections. The section doors must be appropriately colour coded to provide visual distinguishing.

(b) A means shall be provided to isolate both the standby and mains power supplies simultaneously. For this purpose, either a 6-pole rotary switch or mechanically and electrically interlocked circuit breakers or contactors may be used. Electrical interlocking alone is not sufficient. Rotary switches may only be used on panels where the fault level does not exceed 10kA.

(c) A separate 3-pole circuit breaker shall be provided as main switch for both the standby power section and the mains power section in addition to the isolator of (b) above.

Where a 6-pole rotary switch is used as isolator for the incoming supplies, this switch may be located in the standby section of the switchboard in which case the rotary switch can also serve as the isolator for the standby section. This arrangement is acceptable where the equipment on the mains power section of the switchboard can be turned off whenever it is necessary to work on the standby section of the switchboards.

(d) The main switches to the standby and mains power sections shall be interlocked with the doors providing access to those sections to ensure that the door can only be opened when the switches are in the OFF position.

E04.13 ELECTRICAL SUBSTATION FIRE PROTECTION SYSTEM

It is the duty of the Contractor to appoint a trained and competent fire engineering company to design, supply, install, commission, and test and certify a fire protection system for each electrical substation building forming part of the contract.

Each fire protection system will consist out of a fire detection and an extinguishing system as described below. Both systems will be of the highest quality and latest technology, supplied by a reputable manufacturer. The contractor will submit written proof that local support is available to maintain the system and to supply spare parts as required.

E04.13.1 Fire Detection System

The fire detection system must:

(a) Utilise a sub-micron combustion particle detector that detects a fire at its initial stage, before the presence of smoke. This allows preventative action can be taken before any catastrophic event occurs.

(b) Utilise detectors suitable for dusty plant environments and must be impervious to false alarms caused by dust particles in substation buildings with sheet metal roofs where no ceilings are present.

(c) Cover the substation building, all electrical cabinets and all cable trenches.

(d) Only when there is a second alarm from a second detector the system will trigger the gas.

(e) Double Knock system (Trigger an alarm on the first detector activation and trigger the operation of a fire extinguishing system on a second detector activation).

(f) Alert a control and alarm signalling system in case of a fire or a system fault.

(g) Be designed and installed to conform to SANS/ISO 10139 and SANS 369 Parts 1 and 2.

E04.13.2 Fire Extinguishing System

The fire extinguishing system must:

(a) Utilise an automatic system to flood the substation building with a concentration of a gaseous extinguishing agent to extinguishing a fire burning in Class A, B, and C hazards by lowering the oxygen content below the level that supports combustion as quickly as possible.

(b) Utilise a non-toxic, human friendly extinguishing agent. The use of an extinguishing agent that does not support human life must be approved in writing by the Engineer. In this case, other safety measures such as a lockout system should be integrated to ensure safe entrance into the protected substation.

(c) Utilise an efficient extinguishing agent that is electrically non-conductive and that will not adversely affect the protected electrical equipment. No powder or other residue should remain after actuation of the system.

(d) Audible and visual warnings must alert personnel to vacate the protected substation area before discharging the agent.

(e) Utilise a colourless, odourless environment friendly extinguishing agent that is sustainable against impending global warming regulations.

(f) Utilise an extinguishing agent that has a low refill cost.

(g) Should be fully approved by the local authority to an internationally accepted engineering standard.

E04.13.3 Other measures

(a) All points where cable or other services enter the substation building must be properly sealed with a fire rated medium of at least one-hour or as per local standards and regulations.

(b) All ventilation and air conditioning devices must be tripped in the event of first detection of a fire.

(c) All ventilation openings and doors in the substation building should be sealed in the event of first detection of a fire.

(d) A room integrity test needs to be carried out to validate the hold-time for the extinguishing agent as per the room's natural leakage.

(e) All detection, alarm and extinguishing circuits are to be monitored for system faults.

(f) The substation fire protection system should operate a local audible and visual alarm system and report to a central 24-hour manned operations or security room.

(g) A local handheld fire extinguisher should also be installed within the substation as per local regulations. The type and number should conform to local standards and regulations.

E04.13.4 System Maintenance

(a) The contractor will include a fire protection system maintenance contract for a period of one year after commissioning. A trained and competent fire engineering company must do the maintenance.

(b) Thereafter a trained and competent fire engineering company should be contracted to inspect the system on a three-month basis. It should check that the system is operational in terms of its design and take corrective action in the event of a fault.

(c) The Client should visually check the system once a month for any faults reported on the control panel and anything that might appear out of the ordinary. The Client should immediately report to a competent fire engineering contracting company of any concerns or faults to ensure immediate rectification.

(d) A mandatory annual room integrity test should be carried out as per SANS 1520 Part 1.

(e) Should any physical alterations be made to a substation, a review on the fire protection system must be done to see if its performance has been compromised and appropriate actions should be made to ensure the integrity of the system.

E04.14 QA REQUIREMENTS

The vendor / contractor will be responsible for the following.

TABLE OF CONTENTS			
SECTION	**DESCRIPTION**	**REQUIRED (YES OR NO)**	**WHEN REQUIRED**
DRAWINGS & DESIGN (2 SETS OF EACH)	DESIGN CALCULATIONS		
	GA DRAWINGS	YES	ORDER + 3 WEEKS
	DETAIL DRAWINGS	YES	CONSTRUCTION
	AS BUILT DRAWINGS	YES	COMPLETION
	BROCHURES	YES	CONSTRUCTION
	SKETCHES		
	SCHEMATIC DIAGRAMS	YES	ORDER + 3 WEEKS
	RISK ASSESSMENT BY VENDOR	YES	CONSTRUCTION
	DATA SHEETS	YES	TENDER
	DESIGN CRITERIA	YES	CONSTRUCTION
QUALITY CONTROL DOCUMENTS (2 SETS OF	QUALITY CONTROL PLAN	YES	ORDER + 3 WEEKS
	MANUFACTURING PROGRAM	YES	ORDER + 3 WEEKS

EACH)			
MATERIAL CERTIFICATES		YES	MANUFACTURE
CERTIFICATES OF INSPECTION TESTING AND ACCEPTANCE	PRESSURE TEST CERTIFICATE	YES	DATA BOOK
	ELECTRICAL HAZARD CERTIFICATE		
	ELECTRICAL TEST CERTIFICATES	YES	DATA BOOK
	INSTRUMENT CALIBRATION CERTS.		
	VENDORS CERTIFICATE OF CONFORMANCE	YES	COMMISSIONING
	NON-CONFORMITY / CONCESSION REPORTS	YES	COMMISSIONING
MANUALS	OPERATING / MAINTENANCE MANUAL	YES	COMPLETION
	DATA BOOK	YES	DELIVERY – 1 WEEK
	DRAWINGS	YES	COMPLETION
	WARRANTY/GUARANTEES CERTIFICATES	YES	COMPLETION

E04.15 DRAWINGS AND DATA

(a) The vendor / contractor will supply shop drawings to the Engineer prior to manufacturing.

(b) No switchboard manufacturing may start if the drawings are not approved by the Engineer in writing. Should the vendor / contractor start manufacturing without approved shop drawings, any changes required by the Engineer will be for the vendor / contractor's account.

(c) The following will be included in the shop drawings as a minimum:

i. General arrangement drawings

ii. Schematic diagrams

iii. Equipment lists, including the make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.

iv. All labelling information on a separate sheet.

(d) The approval of the shop drawings shall not relieve the Contractor of his responsibility to the Client to supply the switchboards according to the requirements of this specification or to the requirements of the Detailed Technical Specification.

(e) The vendor / contractor will supply three hard copies and one soft copy of the equipment data book including all items as specified in the Vendor QA and document requirement list.

(f) Data books will be supplied to Johannesburg Water within 7 days from delivery of equipment. Johannesburg Water will review the data books within 14 days from issue and notify the Vendor of its acceptance or rejection of it.

(g) All drawings and documentation shall be in accordance with Johannesburg Water specifications bound in book format.

(h) A complete set of "As Built" drawings of all switchboards shall be submitted to the Engineer immediately after completion of the installation. The following information shall be presented:

i. Items (i) and (iv) of the previous paragraph.

ii. Terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilised for the internal wiring.

iii. A separate schedule of all equipment.

(i) Where "As Built" drawings are modified during the execution of the contract, the Contractor shall at his own expense modify or replace such drawings. Accurate drawings of the equipment shall be forwarded to the Engineer.

E04.16 PAINTING AND PROTECTIVE COATING

E04.16.1 Powder Coating Systems

(a) Paint system 1: Powder Coating, seven Stage zinc, Phosphate pre-treatment, pure epoxy primer, Polyester finishing coat, and thickness 140 µm.

Paint System	Host Material	Preparation	Primer (70µm)	Finishing Coat (70µm)	Thickness µm
No 1	Mild Steel	7 stage phosphate pre–treatment	Epoxy	Epoxy	140

(b) On completion of the paint job, the powder manufacturer must carry out the following tests on the test panels:

i. SABS 6J impact test

ii. Cross hatch adhesion test

iii. Bend test

(c) The powder manufacturer must issue a Certificate of Compliance for each paint job, which should be included in the contract documentation.

(d) The preferred corrosion protection systems are applied onto cold rolled mild steel plate with a thickness of 2.0mm.

E04.16.2 Epoxy Powder Coat Products

Item	Product Type	Powder - Lak
1	Epoxy Primer	23-007
2	Pure Epoxy / Polyester Finishing Coat.	Series 3000

E04.16.3 General

(a) All chassis plates shall be painted white.

(b) All mild steel gland plates shall be galvanised for improved cable earthing.

(c) All panel doors on equipment supplied from a normal supply must be painted Electric Orange (B26).

(d) All panel doors on equipment supplied from an emergency supply must be painted Signal Red (A11).

(e) All panel doors on equipment supplied from an UPS supply must be painted Dark Violet (F06).

(f) Specific external colours will be provided by Johannesburg Water.

(g) Before the installation is handed over, the Contractor shall ensure that all paint surfaces are clean and undamaged.

E04.17 PERFORMANCE AND GUARANTEE

(a) The performance of the items supplied in terms of this specification, as defined by the order, shall be warranted by the Vendor and, if specified, be tested in accordance therewith.

(b) The vendor shall not be specifically required to conduct a performance test on site.

(c) A minimum warranty period of 12 months is required.

E04.18 INSPECTION AND TESTING

E04.18.1 Factory Acceptance Test

(a) The Johannesburg Water Representative shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacturing of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation.

(b) The Johannesburg Water Representative is authorised to reject any items not manufactured to the requirements of the specification.

(c) All equipment shall be inspected at the vendor's works prior to delivery, to ensure compliance with the specification.

(d) No unit shall be considered complete until acceptance by Johannesburg Water.

(e) The minimum testing / pre delivery checklist shall be as follows:

i. The Johannesburg Water representative must carry out a clause-by-clause check of each switchboard, prior to delivery.

ii. This switchboard checklist is intended to assist this process but does not relieve him/her of the responsibility described above.

DETAILED INSPECTION ROUTINE

Order No. : _____

Supplier/Vendor : _____

Project : _____

Motor Control Centre Designation : _____

Inspected by : _____

Date : _____

		Comments
Overall Appearance		
□		
□	**Paint work : Compliance with Annexure A5**	
□	**Paint thickness**	
□	**Door fittings good**	
□	**Dust sealing effective (neoprene seals)**	
□	**Board fully assembled**	
□	**Overall height less than specified height**	
□	**Channel iron base frame (less than 3000m)**	
□	**Lifting lugs provided**	
□	**Equipment supplied in accordance with specification (contractors, overloads, circuit breakers, relays, etc.)**	

		Comments
Busbars		
☐	**Correct cross-section**	
☐	**Correct phasing with incomer/feeders**	
☐	**Rigidly supported/braced**	
☐	**Properly insulated**	
☐	**Joints tightened**	
☐	**Transport section joints supplied (Fishplates, nuts and bolts, control wiring and terminals, etc.)**	
☐	**Droppers from main bars to circuit breakers adequately rated, braced, insulated**	
☐	**Nothing unnecessary mounted on bus bars**	
☐	**Main earth bar, min 70mm²**	
☐	**Control busbars generally as above, separate from power busbars**	
☐	**Air clearances adequate throughout**	
Single Line Diagram Check		
☐	**As per approved single line diagram**	
Outgoing Circuit		
☐	**Correct size/rating for MCCB's**	
☐	**Correct size/rating for ACB's**	
☐	**Correct earth leakage relays**	
☐	**Correct current transformer and associated ammeters**	
☐	**Correct overload relays**	
☐	**Correct setting on overload relays**	
☐	**Reasonable provision for cable termination power and control mounting of equipment**	
☐	**Correct conductor sizing, power and control, and correct colouring**	
☐	**Correct indicator lights and colours**	
☐	**Air clearances correct throughout**	
Incoming Circuits		
☐	**Correct size/rating of ACB's**	
☐	**Correct metering and proper mounting**	
☐	**Connection of power factor meter**	
☐	**Fuses on volt meter, where applicable**	
☐	**Reasonable provision for termination of incoming cable/gland plate**	
☐	**Air clearances correct throughout**	
	Incomer status signal to PLC	
	Interlocks	
Pressure and Injection Tests		
☐	**Primary injection test for correct operation of all protection and overload relays**	
Operational Test		
☐	**Mechanical operation of all circuit breakers, preferably with doors closed**	
☐	**Shunt trip of all circuit breakers**	
☐	**Operation of overload relay**	
☐	**Correct operation of all interlocks**	
☐	**Correct operation of indicator lights**	

		Comments
□	**Correct operation of earth fault/overload alarm system, including general alarm panel**	
	Correct signals to PLC terminals	
	Correct interlocks	
	Door interlocks	
General Checks		
□	**Marking of control wires and power conductors**	
□	**Main Motor Control Centre label**	
□	**Cubicle labels fitted – designation and cubicle number**	
□	**Component labels fitted**	
□	**Warning labels on all removable covers giving access to live 400V conductors**	
□	**Labels for indicator lights, pushbuttons, etc.**	
□	**Terminal strip labels**	
□	**Incoming side of circuit breakers label**	
□	**Incoming circuit label – "FROM _____"**	
□	**No 'Philips' (star) screws**	
□	**No self-tapping screws**	
□	**Grommets fitted on all open holes**	
□	**Correct paint specification**	
□	**All documentation submitted**	
□	**Arc venting arrangements satisfactory**	
□	**Door latches fitted**	

(f) Specific testing and inspection requirements relating to switchgear boards are as follows:

i. Prior to shipment, the switchgear boards shall be completely assembled, wired, adjusted and tested by the supplier in the presence of the engineer and the client representative.

ii. Testing shall include primary injection tests of all current transformers, pressure tests to prove quality of insulation, functional tests of all mechanical and electrical components and electrical circuitry and any other tests required to ensure compliance with this specification.

iii. The supplier shall give one week's notice of readiness for final tests to the Johannesburg Water representative. The vendor shall ensure that the equipment is ready for final testing before requesting the presence of the Johannesburg Water representative at such a test. Repeat inspections necessitated by the lack of readiness of the equipment may be charged to the vendor at the discretion of the Johannesburg Water representative.

E04.18.2 <u>Site Acceptance Test and Commissioning</u>

(a) A Site Acceptance Test (SAT) must be conducted at the place of installation prior to switching the DB on. The test shall include (as a minimum) the following:

i. A visual inspection to ensure all the design specifications are adhered to;

ii. Insulation resistance test;

iii. Function testing of all components.

iv. All switchboards must be thermal imaged a minimum of 1 week after being put on service. The image must be taken in normal operating conditions. The image must be analysed for hot spots and must be part of the Operations and Maintenance

Manuals presented at the end of the project.

E04.19 MEASUREMENT AND PAYMENT

Item Unit

Supply and deliver Switchboards or Motor Control Centres ..... No

The unit of measurement shall be the number of MCC's or boards supplied and delivered.

The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the boards as specified in the detailed specification.

Item Unit

Install Switchboards or Motor Control Centres ..... No

The unit of measurement shall be the number of MCC's or boards installed.

The tendered rates shall include full compensation for the installation of the specified boards, including all required installation material to install the MCC or board in the required position including a heavy-duty strut, mounted 400mm below the gland plate. All incoming and outgoing cables shall be attached to this strut by means of K-clamps or approved equivalent clamps.

Item Unit

Commission Switchboards or Motor Control Centres ..... No

The unit of measurement shall be the number of MCC's or boards.

The tendered rates shall include full compensation for the site testing and commissioning of the specified boards including the keeping of all commissioning records in triplicate, including all material, test equipment and labour required for the testing and commissioning.

Item Unit

Supply and install extra circuits on Switchboards and Motor Control Centres ..... No

The unit of measurement shall be the number of circuits supplied and installed.

The tendered rate shall include full compensation for the manufacture, supply, testing and installing of extra circuits in switchboards or motor control centres (spare space being available on the board).

Item Unit

Supply and deliver level control equipment ..... No

The unit of measure shall be the number of level control systems supplied and delivered.

The tendered rate shall include full compensation for the supply, manufacturing, testing and delivery of all the material required for the level control system, including all float level switches, will the required length of cable attached to them, mounting brackets, terminal box and mounting equipment together will all material to facilitate a complete level control system.

Separate items will be measured for systems with different numbers of level switches.

Item Unit

Install level control equipment ..... No

The unit of measure shall be the number of level control systems installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the level control system including the required brackets, junction boxes, cables etc. for a complete working system.

Item Unit

Modify existing motor starter panels ..... No

The unit of measure shall be the number of motor starters to be modified.

The tendered rate shall include full compensation for the supply and delivery of all material and labour required to modify the motor starter panel as detailed in the detail specification.

Item Unit

Supply and install PLC/Scada alarm and status signals ..... No

The unit of measure shall be the number of MCC's for which a siren and alarm light has been installed.

The tendered rate shall include for the full compensation for the supply, delivery, installation and commissioning of the specified siren and alarm light including all required installation material including cables required to render a fully operational system.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E07 : ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E07 : Electrical Industrial Welding Plugs, Couplers and Socket Outlets**

JW Reference: **BWW523C**

Document Ref. No: **E07**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

CONTENTS

E07.1 SCOPE....3

E07.2 STANDARDS....3
E07.2.1 National Standards....3
E07.2.2 Particular specifications to be read in conjunction with this specification....3

E07.3 GENERAL REQUIREMENTS....3
E07.3.1 Single phase 16A household and similar purpose socket outlet....3
E07.3.2 Single phase 16A industrial socket outlet....3
E07.3.3 Three phase 63A industrial welding socket outlet (5-pin)....4

E07.4 TESTING AND COMMISSIONING....4

E07.5 MEASUREMENT AND PAYMENT....5

E07.1 SCOPE

This specification covers the procurement, supply, delivery, installation testing and commissioning of the required industrial welding plugs, couplers and socket outlets for industrial purposes.

E07.2 STANDARDS

E07.2.1 National Standards

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a)	SANS 1222	:	Enclosures for electrical equipment classified by IP code
(b)	SANS 1239	:	Plugs, socket-outlets and couplers for industrial purposes
(c)	SANS 6309	:	Plugs, socket-outlets and couplers for industrial purposes
(d)	SANS 1091	:	National colour standard
(e)	SANS164-2		Plug and socket-outlet systems for household and similar purposes for use in South Africa Part 2: Two-pole and earth and 2 pin (Class II), 16 A 250 V a.c. system.
(f)	SANS 10142-1	:	The Wiring of Premises Part 1 – Low Voltage Installations

E07.2.2 Particular specifications to be read in conjunction with this specification

(a)	E26	:	ELECTRICAL SPECIFICATION FOR COLOUR CODES
(b)	G02	:	PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
(c)	E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(d)	E08	:	WIRING

E07.3 GENERAL REQUIREMENTS

Switched 400V 3-phase, 3-wire and earth 63A industrial welding socket outlet plus a switched 230V, single phase, 3-wire 16A industrial socket outlet shall be supplied. A 4-core cable shall be used with an earth included in the supply cable.

E07.3.1 Single phase 16A household and similar purpose socket outlet

Applied to general household, commercial and light industrial installations up to 250Vac 16 A.

(a) Compliance: SANS 164-2/SANS10142-1

(b) Wall mounted socket;

(c) Be of the two-pole earthing contact type;

(d) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;

E07.3.2 Single phase 16A industrial socket outlet

(e) Wall mounted socket;

(f) Pin and sleeve configuration;

(g) 2 pole, 3-wire with 2P+E 230V ac, 16A;

(h) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;

(i) Ingress protection IP67 (SANS 1222);

(j) Switched locally on the socket outlet;

(k) Mechanical interlock to prevent plugs from being engaged or disengaged under load;

(l) Lockable by a padlock (40mm) at the switch-off position.

E07.3.3 Three phase 63A industrial welding socket outlet (5-pin)

(a) Compliance: SANS 60309-1

(b) 415Vac 3phase, neutral and protective earth (5 pin), 63A current rating

(c) Housing: Powder coated die-cast aluminium

(d) Colour: Electric orange RAL B26

(e) Wall mounted socket with top cable entry with removable flange;

(f) Pin and sleeve configuration;

(g) 3-phase earth leakage protection unit mounted in the feeder cubicle in the MCC/DB;

(h) Rated ingress protection IP55 (SANS 1222);

(i) Switched locally on the socket outlet, lockable by a padlock (40mm) at the switch-off position;

(j) Mechanical interlock: The isolator cannot be “Switched ON” without the plug inserted and the plug cannot be removed while the isolator is in “ON” position

(k) Matching metal clad plug top, 415Vac 3-phase 5 pin, 63A, IP55 to be supplied with the socket outlet.

Where pilot wire connections are required, they shall disconnect before the main phase connectors disconnect.

The equipment enclosures shall be IP55 to SANS 1222. Socket outlets that are exposed to the atmosphere or installed in damp areas, shall be minimum rated at IP 56 or as otherwise specified by the engineer. All sockets shall be constructed of corrosive resistant materials.

Both types of sockets shall be mounted on a 304 stainless steel heavy duty pedestal. The socket outlet mounting height shall be 1200 mm above finished ground level.

A purpose made metal junction box of IP65 rating to SANS 1222 fitted with a canopy shall be provided and mounted on the stand above the socket outlet in such a way that the junction box does not interfere with the use of the socket outlet. The supply cable to the welding socket shall be terminated in the junction box. Where the cross sectional area of the cores of the supply cable to the welding socket outlet exceeds 16 mm^2, the cable core size from the junction box terminals to the socket outlet shall be 16mm^2, 4-core. The 16A single-phase socket shall have its own dedicated supply.

The junction box including the canopy and the welding socket stand shall be powder coated /painted B26 – Light Orange (1673-Y48R) to SANS 1091.

E07.4 TESTING AND COMMISSIONING

During testing and commissioning, the contractor shall:

(a) Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications;

(b) The rating of all equipment is as specified;

(c) Test all earth leakage protection units supplied to confirm the tripping current.

E07.5 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply / delivery and installation / commissioning of industrial welding plugs, sockets, connectors etc.

Item **Unit**

Supply and deliver of welding plugs and switched socket outlets complete with plugs ..... No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes supplied and delivered.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets.

The tendered rate shall include all costs related to the supply and delivery of the specified switched socket outlet and plugs and shall include for the stands and junction boxes required.

Item **Unit**

Install and commission welding plugs and switched socket outlets ..... No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes installed and commissioned.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets and whether the plug must be installed on a cable or whether the plug must be handed over to the employer.

The tendered rate shall include full compensation for the installation of the switched socket outlet and plugs as detailed in the detail specification including all required material and labour to render a complete and working installation, including all labour and material required for installing the plug on the cable as detailed or for handing over the plug (free issue) to the employer and obtaining a receipt therefore.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E08 : ELECTRICAL WIRING

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E08 : Electrical Wiring**

JW Reference: **BWW523C**

Document Ref. No: **E08**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E08: ELECTRICAL WIRING

CONTENTS

E08.1 SCOPE....3

E08.2 STANDARDS....3

E08.3 GENERAL REQUIREMENTS....3

E08.4 DRAWING OF CONDUCTORS....3

E08.5 WIRING METHOD....3

E08.6 SIZE OF CONDUCTORS....3

E08.7 DIFFERENT PHASES....4

E08.8 TESTING AND COMMISSIONING....4

E08.9 MAINTENANCE INSTRUCTIONS AND GUARANTEES....4

E08.10 MEASUREMENT AND PAYMENT....4

E08.1 SCOPE

This specification covers the wiring requirements of electrical installations.

E08.2 STANDARDS

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations

(b) SANS 1411-2 : Materials of insulated electric cables and flexible cords: Part 2 – Polyvinyl Chloride (PVC)

(c) SANS 1507 : Electric Cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)

E08.3 GENERAL REQUIREMENTS

PVC insulated conductors for general wiring shall consist of high conductivity annealed copper wire strands with polyvinyl chloride insulation. The insulation shall be compounded and stabilised to comply with SANS 1411-2 as amended.

Conductors shall be finished in the required colours and shall be manufactured in accordance with SANS 1507 as amended.

Any special requirement regarding the type and size of wiring to be installed in a specific installation shall be specified.

E08.4 DRAWING OF CONDUCTORS

Wiring shall only be carried out after the wireway installation is completed, but before painting has commenced. No conductors shall be installed before the wireways have been cleaned of all debris and moisture. Wireways shall contain no sharp edges.

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted.

E08.5 WIRING METHOD

All wiring shall be carried out according to the loop-in system. When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

When connecting more than one conductor in a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

E08.6 SIZE OF CONDUCTORS

The following minimum conductor sizes shall be used:

Bell circuits = 1.5 mm^2
Clock circuits = 1.5 mm^2
Lighting circuits = 1.5 mm^2
Plug circuits = 2.5 mm^2
All the above = 2.5 mm^2 earth conductor
Motor circuits = As specified

E08.7 DIFFERENT PHASES

With the exception of three-phase outlets, circuits connected to different phases shall not be present at light, switches or socket-outlet boxes.

E08.8 TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) The requirements of the Local and Supply Authorities.

E08.9 MAINTENANCE INSTRUCTIONS AND GUARANTEES

E08.10 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply and deliver LV conductors	m

The unit of measurement shall be the linear length of conductor supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery to site of the specified conductors. Conductors will be measured linearly along the full length installed in the wireway and sufficient provision will be made in the quantities for conductor slack at outlet boxes and distribution board trays. No extra will be allowed for jointing, overlapping and wastage at connections.

Separate items shall be scheduled for each conductor size.

Item	**Unit**
Install LV conductors in conduit	m

The unit of measurement shall be the linear length of conductors installed in conduit.

The tendered rate shall include full compensation for the handling, inspection, pulling in conduit the specified number and sizes of conductors, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at outlet boxes and distribution board trays to make the necessary connections to equipment.

Separate items shall be scheduled for each size of conductor.

Item	**Unit**
Install LV conductors in trunking	m

The unit of measurement shall be the linear length of conductors installed in trunking.

The tendered rate shall include full compensation for the handling, inspection, installing in trunking the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors.

Separate items shall be scheduled for each size of trunking and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, clamps and other materials

necessary to ensure that the wiring conforms to the specification.

Item **Unit**

Install LV conductors in power skirting.....m

The unit of measurement shall be the linear length of conductor installed in power skirting.

The tendered rate shall include full compensation for the handling, inspection, installing in power skirting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets.

Separate items shall be scheduled for each type of power skirting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to the specification.

Item **Unit**

Install LV conductors in floor ducting .....m

The unit of measurement shall be the linear length of conductors installed in floor ducting.

The tendered rate shall include full compensation for the handling, inspection, installing in floor ducting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets. Were cables are exposed to the sun they shall be strapped, using stainless steel strapping.

Separate items shall be scheduled for each type of floor ducting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to specification.

Item **Unit**

Supply conductor terminals..... No

The unit of measurement shall be the number of conductor terminals supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the specified terminals complete with mounting rail and all hardware required to fasten the terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

Item **Unit**

Install conductor terminals ..... No

The unit of measurement shall be the number of conductor terminals installed.

The tendered rate shall include full compensation for the handling, inspection and installation of the specified terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

Item **Unit**

Supply PVC insulated multicore cables .....m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

Item **Unit**

Install PVC insulated multi core cables.....m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

Item **Unit**

Supply and install the terminations for PVC multicore cables ..... No

The unit of measurement shall be the number of terminations installed.

The tendered rate shall include full compensation for the supply and installing of the terminations as specified.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E09 : ELECTRICAL BUILDING INSTALLATION

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 4

August 2019

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E09 : Electrical Building Installation**

JW Reference: **BWW523C**

Document Ref. No: **E09**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E09: ELECTRICAL BUILDING INSTALLATION

CONTENTS

E09.1 GENERAL 4

E09.2 STATUTORY DOCUMENTS AND STANDARDS 4
E09.2.1 Standards 4
E09.2.2 Regulations, Acts and Bylaws 4
E09.2.3 Particular Specifications to be read in conjunction with this specification 4

E09.3 ARRANGEMENTS WITH THE SUPPLY AUTHORITY 5

E09.4 FIXING AND SUPPORTING OF EQUIPMENT AND MATERIALS 5

E09.5 ELECTRICAL CONDUIT INSTALLATION 6
E09.5.1 General 6
E09.5.2 Other Services 6
E09.5.3 Galvanised Conduit 6
E09.5.4 Debris 6
E09.5.5 Defects 6
E09.5.6 Conduit Ends 6
E09.5.7 Joints 6
E09.5.8 Finish 6
E09.5.9 Continuity 6
E09.5.10 Inspection Type Accessories 6
E09.5.11 Position of Outlets 6
E09.5.12 Draw Wires 7
E09.5.13 Bends 7
E09.5.14 Wall Sockets 7
E09.5.15 Luminaires 7
E09.5.16 Withdrawal of Conductors 7
E09.5.17 Temperature Differences 7
E09.5.18 Flush Mounted Outlet Boxes 7
E09.5.19 Excess Holes 7
E09.5.20 PVC Conduit 7
E09.5.21 Terminations 8
E09.5.22 Open Roof Spaces 8
E09.5.23 Installation in Concrete and Screeds 8
E09.5.24 Surface Installation 9
E09.5.25 Flexible Conduits 10
E09.5.26 Stove connection 10
E09.5.27 Expansion Joints 11
E09.5.28 Chases and Builder's Work 11
E09.5.29 Connections to Switchboards 12

E09.6 CABLE TRAYS AND LADDERS 12

E09.7 WIRING DUCTS 12
E09.7.1 Responsibility of the Contractor 12
E09.7.2 Materials and Finishes 12
E09.7.3 Cover Plates 13
E09.7.4 Connections 13
E09.7.5 Support for Conductors 13
E09.7.6 Vermin Proofing 13
E09.7.7 Earth Continuity 13
E09.7.8 Internal Finishes 13
E09.7.9 Services 13
E09.7.10 Vertical Installation 13
E09.7.11 Number of Conductors 13
E09.7.12 Fixing 13
E09.7.13 Installation in Concrete 14

E09.7.14 Fire Barrier 14
E09.7.15 Conduit Connection 14

E09.8 INSTALLATION OF LUMINAIRES 14
E09.8.1 Positions 14
E09.8.2 Cover Plates 14
E09.8.3 Hanger and Supports 14
E09.8.4 Suspended Cable Channels 14
E09.8.5 False Ceilings 14
E09.8.6 Fluorescent Luminaires Fixed to Concrete Slabs 14
E09.8.7 Fluorescent Luminaires Fixed to False Ceilings 15
E09.8.8 Continuous Rows of Luminaires 15
E09.8.9 Recessed Luminaires 15
E09.8.10 Special Ceilings 15
E09.8.11 Waterproof Luminaires 15
E09.8.12 Bulkhead Luminaires 15

E09.9 INSTALLATION OF LIGHT SWITCHES 15
E09.9.1 Mounting 15
E09.9.2 Doors 15
E09.9.3 Walls 16
E09.9.4 Switch Boxes 16
E09.9.5 Cover Plates 16
E09.9.6 Escutcheon Plates 16
E09.9.7 Surface Mounted Switches 16
E09.9.8 Cutting of Cover Plates 16
E09.9.9 Partitions 16
E09.9.10 Waterproof Switches 16
E09.9.11 Appearance 16

E09.10 INSTALLATION OF SOCKET OUTLETS 16
E09.10.1 Mounting Heights 16

E09.11 PROVISION FOR TELEPHONE INSTALLATION 17
E09.11.1 General 17
E09.11.2 Regulations 17
E09.11.3 Sleeves for Main Cables 17
E09.11.4 Separation of Services 17
E09.11.5 Main Telephone Distribution Board 17
E09.11.6 Telephone Outlets 18
E09.11.7 Connection of Telephone Outlets 18

E09.12 SWITCHBOARDS AND DISTRIBUTION BOARDS 18

E09.13 NOISE AND VIBRATION 18

E09.14 COMMISSIONING AND TESTING 19

E09.15 LABELLING AND IDENTIFICATION 19

E09.16 OPERATING AND MAINTENANCE MANUALS; "AS BUILT" OR "AS INSTALLED" RECORD DRAWINGS 20

E09.17 TESTING AND COMMISSIONING 21

E09.18 MAINTENANCE INSTRUCTIONS AND GUARANTEES 22

E09.19 MEASUREMENT AND PAYMENT 22

E09.1 GENERAL

The Particular Specification shall be read in conjunction with the Detailed Technical Specification.

Where the Detailed Technical Specification is in contradiction with this Particular Specification, the former shall apply to this contract.

E09.2 STATUTORY DOCUMENTS AND STANDARDS

E09.2.1 Standards

The installation shall be erected and carried out in compliance with:

(a) SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
(b) SANS 60529	:	Degrees of protection provided by enclosures (IP Code)
(c) SANS 10400-FR	:	National Building Regulations and Building Standards Act (Act 103 of 1977), as amended
(d) SANS 60529	:	Degrees of protection provided by enclosures (IP Code)

E09.2.2 Regulations, Acts and Bylaws

The installation shall be erected and carried out in compliance with the latest edition of the following:

(a) Occupational Health and Safety Act (Act 85 of 1993) and Regulations;

(b) Construction Regulation;

(c) Applicable By-Laws and Regulations as implemented by the Local Authority;

(d) Fire Regulations as implemented by the Local Authority.

E09.2.3 Particular Specifications to be read in conjunction with this specification

This specification shall also be read in conjunction with the following specifications:-

(a) E02	:	ELECTRICAL CABLE RACKS
(b) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(c) E08	:	WIRING

In addition, the Contractor shall issue all notices and pay all the required fees in respect of the installation to the local authorities, and shall exempt the Employer from all losses, costs or expenditures that may arise because of the Contractor's negligence to comply with the requirements of the regulations enumerated in paragraph 9.2.

It is assumed that the Contractor is conversant with the above-mentioned requirements. Should any requirements, by-law or regulation, which contradict the requirements of this document, apply or become applicable during erection of the installation, such requirement, by-law or regulation shall overrule this document and the Contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the Contractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Engineer.

E09.3 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

It shall be the responsibility of the Contractor to issue all notices and pay all monies that are due for the electrical builders / temporary supply connection, except where otherwise specified. If, according to the contract, these monies are reclaimable from the Employer, then these claims by the Contractor shall be substantiated with official receipts.

It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with the local supply authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

The Contractor shall supply and install all signage, notices and warning signs that are required by the appropriate laws, regulations and/or by this document.

E09.4 FIXING AND SUPPORTING OF EQUIPMENT AND MATERIALS

(a) It is the responsibility of the Contractor to position and securely fix conduits, wiring ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the installation. The Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

(b) All supporting steelwork shall be wire-brushed and given one coat of rust resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.

(c) Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission has been obtained. Drilling of holes into or welding onto steel structural members is only allowed where prior permission has been obtained.

(d) All methods of suspension or supports shall be submitted to the Engineer for approval and for reference to the Structural Engineers where necessary, prior to manufacture or installation.

(e) Supporting of any rotating equipment shall incorporate anti-vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.

(f) Supports shall preferably be strut channel, shall be of mild steel sections, purpose fabricated for their application. Under no circumstances whatsoever will sheet metal straps be accepted as a supporting method. All supports shall cradle the item to be supported; supports shall not be riveted or welded to the equipment. Rod hangers shall not exceed 3000mm in length and be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle profile supports shall be of 38 x 5mm minimum section.

(g) Where holes in equipment exist, bolts and fixing screws as specified shall be used. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.

(h) Anchor bolts shall be used for fixing supports to brick or concrete walls, it not being permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.

(i) Where the fixing holes in brick or concrete walls are smaller than 10mm diameter and where the mass of the equipment is less than 15kg, wall plugs may be used to fix conduits, cables and other equipment. Aluminium, fibre or plastic plugs only may be used. Wooden plugs are not acceptable. Plugs installed in seams between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round headed screws shall be used throughout.

(j) Where the fixing holes are 10mm and larger or where the mass of the equipment is 15kg or more, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete.

(k) Galvanised screws, bolts and nuts shall be used to fix galvanised equipment.

(l) No shot-fired or explosion driven tools will be allowed.

E09.5 ELECTRICAL CONDUIT INSTALLATION

E09.5.1 General

Where conduits are to be installed in concrete, this shall be done while the building work is still in progress. Surface mounted conduit shall only be installed after the concrete has cured sufficiently.

E09.5.2 Other Services

Conduits may not be installed closer than 150mm to pipes containing gas, steam, hot water or other materials which may damage the conduits. Conduits may not touch pipes or other service installations in order to prevent electrolytic corrosion. Where doubtful situations of this nature occur or where there are installation incompatibilities, the matter shall be reported to the Engineer immediately.

E09.5.3 Galvanised Conduit

Galvanised conduit and accessories shall be used under all circumstances:

Conduit and accessories shall be hot-dipped galvanised to SANS 32: Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants and SANS 121: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

E09.5.4 Debris

Care shall be taken to prevent any debris or moisture from entering the conduit during and after installation of the conduits. All conduit ends shall be sealed by means of a solid plug, which shall be screwed to the conduit end. All conduits shall be cleaned to remove all oil, moisture or other debris that may be present, before conductors are installed.

E09.5.5 Defects

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges shall be removed from site. The Contractor shall ensure that conduits are not blocked.

E09.5.6 Conduit Ends

Conduit ends shall be cut at right angles to ensure that ends butt squarely at joints. Threads shall not be visible at joints and connections except at running joints for steel conduits.

E09.5.7 Joints

All conduit ends shall be reamed and all joints tightly screwed. Only approved couplings shall be used. Running joints with long threads shall be kept to a minimum and locknuts shall be provided to ensure a strong mechanical and a continuous electrical joint for steel conduits.

E09.5.8 Finish

All joints shall be painted with cold galvanizing paint to prevent them from rusting in damp areas, and in cases where the installation is exposed to the weather for any length of time. Where the galvanising finish was damaged, the area shall first be cleaned and a coat of cold galvanizing paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has been completed.

E09.5.9 Continuity

Mechanical and electrical continuity shall be maintained throughout the conduit installation. The use of conduits as earth continuity conductors are not allowed.

E09.5.10 Inspection Type Accessories

Inspection type couplings, elbows and tees shall not be used except with the written consent of the Engineer. All outlet boxes and draw boxes shall however be of the inspection type.

E09.5.11 Position of Outlets

All accessories such as socket outlets, switches, lights, etc., shall be accurately positioned. It is the responsibility of the Contractor to ensure that all accessories are installed level and

square at the correct height from the floor, ceiling or roof level as specified. It shall be the responsibility of the Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw boxes shall be installed in inconspicuous positions to the approval of the Engineer. All installed draw boxes shall be pointed out to the Engineer. The positions of all draw boxes shall be indicated on the 'as-built' drawings.

E09.5.12 Draw Wires

Galvanised steel draw wires shall be installed in all unwired conduits, e.g. conduits for future extensions, telephone installations and other services.

E09.5.13 Bends

A maximum of two 90º bends or the equivalent displacement will be allowed between outlets and/or draw boxes. Draw boxes shall be installed at maximum intervals of 12m in straight conduit runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside diameter of a bend shall not be less than three times the outside diameter of the conduit.

E09.5.14 Wall Sockets

Where more than one socket outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without the jointing of wires.

E09.5.15 Luminaires

Conduit end may not be used to solely support luminaires. Where luminaires are specified which are fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

E09.5.16 Withdrawal of Conductors

To ensure that all electrical conductors shall be easily withdrawable from conduits, the Engineer reserves the right to have the conductors on any circuit removed at his discretion and replaced at the cost of the Contractor. If the conductors are damaged during removal, the damaged conductors shall be replaced and the cost of the replacement shall be borne by the Contractor.

E09.5.17 Temperature Differences

Should the conduit installation be subject to temperature gradients at the same time, an expansion joint shall be installed in a suitable position to accommodate expansion and contraction. The conduit at the higher temperature shall be insulated from the rest of the installation with a suitable material. The above conditions for example apply where conduits leave cold rooms.

E09.5.18 Flush Mounted Outlet Boxes

The edges of flush mounted outlet boxes shall not be deeper than 10mm from the final surface. Where this is not the case, an extension box which ends flush with the surface, shall be screwed to the outlet box. This method shall be used in partitions and clad surfaces.

E09.5.19 Excess Holes

All excess holes in draw boxes, distribution boxes, switchboards, cable ducts or trunking, power skirting, etc., shall be securely blanked off to render the installation vermin proof.

E09.5.20 PVC Conduit

The use of PVC conduit shall not be allowed, only if stated in the Detailed Technical Specification portion of the document.

E09.5.21 Terminations

E09.5.21.1 Switchboards, Power Skirting, Etc.

A female bush and two lock nuts shall be installed where conduits terminate in pressed steel switchboards and distribution boxes, cable ducts, power skirting, etc. The conduit end shall only project far enough through the hole to accommodate the bush and lock nut.

E09.5.21.2 Draw Boxes

A female bush and lock nut must be used to terminate conduits at draw boxes and outlet boxes without spouts.

E09.5.22 Open Roof Spaces

E09.5.22.1 Sequence of Work

Conduits and wiring in open roof spaces above ceilings other than concrete slabs must be installed before the ceilings and walls are painted and before removable ceiling tiles are installed. In roof spaces where access is limited after installation of the ceiling. It is the responsibility of the Contractor to ensure close liaison with the Main Contractor in connection with the work.

E09.5.22.2 Fixing

All conduits is open roof spaces shall be installed parallel and at right angles to the roof members and shall be fixed to the structures at intervals not exceeding 1 metre. Approved saddles shall be used throughout. Clout nails, clamps or wood screws shall be used to secure the saddles to wooden roof members. Saddles which comply with the requirements of this specification shall be used to secure conduits against concrete slabs. Written permission shall be obtained to secure conduits to steel beams in which case saddles shall be fixed by means of bolts, nuts and lock washers or purpose made saddles shall be used.

E09.5.22.3 Cross-Overs

Crossovers in conduit routes shall be minimised. Where crossovers are unavoidable offset one conduit only to cross the other conduit. Where several conduits enter the same draw box, they shall as far as possible be installed parallel to each other.

E09.5.22.4 Draw Boxes

Install draw boxes with metal cover plates where required and as far as possible near gangplanks. The use of socket and switch boxes instead of draw boxes in open roof spaces is unacceptable.

E09.5.22.5 Positions of Accessories

Install conduits in open roof spaces, which is accessible after completion of the building to allow wiring or inspection from a position above the conduits. Install conduits in ceiling voids with less than 900mm clear space between the ceiling and the roof, to permit wiring and inspection from a position below the conduits. Loop conduits between outlet boxes.

E09.5.22.6 Incandescent Luminaires

Where luminaires are secured directly to draw boxes in false ceilings or where ceiling roses or special connections are used, flush mounted, rear entry round draw boxes that are independently fixed to roof beams, shall be provided.

E09.5.22.7 Conduit Ends

All conduit ends for lighting outlets in ceilings shall be securely supported.

E09.5.22.8 Fluorescent Luminaires

Draw boxes for fluorescent luminaires shall be installed as specified in the previous paragraph but luminaires shall be installed as specified in paragraph 9.5.22.6.

E09.5.23 Installation in Concrete and Screeds

The Contractor must position all conduits and accessories casted in concrete in good time to prevent building delays.

In order not to delay building operations, the Contractor shall ensure that all conduits and accessories that casted in concrete are positioned in good time. The Contractor or his representative must attend when the concrete casting.

E09.5.23.1 Draw Boxes

Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. In hollow tile slabs, rear-entry draw boxes shall be used. In columns where flush mounted draw boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw box.

E09.5.23.2 Cover Plates

Where possible draw boxes and/or inspection boxes shall be grouped together under a common approved cover plate. The cover plate shall be secured by means of screws.

E09.5.23.3 Fixing to the Shuttering

All conduits, draw boxes etc., shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

E09.5.23.4 Concrete Floor Slabs

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations or other damp areas. Equipment in damp areas shall only be supplied from above by means of multi-core PVC-insulated cables which shall either be installed in galvanised steel ducting or on galvanised cable trays. All socket outlets and three phase outlets in damp areas shall be supplied from above.

E09.5.23.5 Screeds

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2,0m.

E09.5.23.6 Inspection

All draw boxes, conduits, etc., which are installed in concrete shall be cleaned with compressed air and provided with draw wires two days after removal of the shuttering. Errors that occur during the installation of the conduits, or any lost draw boxes, or blocked conduits, shall be immediately reported to the Engineer in order that an alternative route can be planned and approved by the Engineer before the additional concrete is cast. Any additional cost shall be to the Contractor's account.

E09.5.24 Surface Installation

Except where installed in ceiling spaces, the installation of conduit on the surface of walls and concrete slabs will only be allowed when authorised, in writing, by the Engineer. Where surface conduits are specified, saddles shall be of the hospital (spacer) type.

E09.5.24.1 Building Lines

All conduits shall be installed horizontally or vertically as determined by the route and the Contractor shall take all measures to ensure a neat installation. Where conduits are to be installed directly alongside door frames, beams, etc., that are not true, conduits shall be installed parallel to the frames, beams, etc. When in doubt, the Contractor shall consult the Engineer before installation is commenced.

E09.5.24.2 Saddles

Conduits shall be firmly secured by means of saddles spaced at maximum intervals of 2000mm with at least two saddles per run. Saddles shall be submitted to the Engineer for

approval prior to commencement of installation. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 250mm before and after each 90° bend.

E09.5.24.3 Joints

Joints will not be allowed in conduit lengths not exceeding 3500mm when these conduits are installed on the surface of a wall. Threads shall not be visible at joints of completed installations, except where running joints are used. Running joints will be allowed only when absolutely necessary. All running joints shall be provided with lock nuts and shall be painted with red lead immediately after installation.

E09.5.24.4 Accessories

Inspection bends or tee pieces shall not be used. Non-inspection type bends may be used in the case of 40mm or 50mm diameter conduits. All draw boxes supporting luminaires or other equipment shall be fixed independently of the conduit installation.

E09.5.25 Flexible Conduits

In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection to thermostats and sensors on equipment, for stove connections and where otherwise required by the Engineer, flexible conduit shall be used for the final connection to the equipment.

The lengths of flexible conduit shall be as short as possible to comply with the requirements of the particular connection but shall not exceed 600mm, except when specified or approved by the Engineer.

Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw box. The flexible conduit may be connected directly to the end of a conduit if an existing draw box is available within 2000mm of the junction and if the flexible conduit can easily be rewired.

Flexible conduit shall consist of metal-reinforced plastic conduit or PVC covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel construction may be used. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass or cadmium or zinc plated mild steel. The requirements of paragraphs 9.5.9 are applicable.

Where the possibility exists that the conduit can come into contact with moisture, suitable covering and/or packing shall be installed to isolate the conduit from the moisture.

Flexible conduit connections shall be provided with an internal or external earth wire connection as required by the local Supply Authority, with preference given to internal earth wires where no specific local regulations apply.

E09.5.26 Stove connection

A freestanding stove, rated above 16A must be plugged in by means of a stove coupler (see figure 1). The stove coupler, which shall comply with SABS IEC 60309-with a minimum of 45Amp single-phase and 16 A per phase for three-phase. The open end of the connector tube shall point downwards.The switch-disconnector for the cooking appliance shall

(a) be in the same room as the appliance,

(b) be at a height above floor level of not less than 0, 5 m and not more than 2, 2 m,

(c) not be above the cooking appliance,

(d) be within 3 m of the appliance, but within 0, 5 m of the appliance if the switch-disconnector's purpose is not clearly indicated, and

(e) not be fixed to the appliance.



Figure 1: Stove coupler

E09.5.27 Expansion Joints

Where conduits cross expansion joints in the structure, approved type draw boxes which provide a flexible connection in the conduit installation shall be installed.

The draw box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts.

The circuit conduit passing through the sleeve shall be terminated 40mm inside the draw box. The gap between the sleeve and the conduit at the joint shall be sealed to prevent the ingress of wet cement.

The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means a 2,5mm^2 copper wire(minimum) with lugs and brass screws.

Draw boxes at the expansion joint shall be provided with a suitable steel cover plate fixed to the boxes by means of screws. The cover plates shall be installed before the ceilings are painted by others.

E09.5.28 Chases and Builder's Work

Except where otherwise specified, the Contractor shall be responsible for the builder's work connected with conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes as well as the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for luminaires and other electrical outlets. The Contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Contractor to ensure that these requirements are met.

Electrical materials to be built in must be supplied, placed and fixed in position by the Contractor when required by the Main Contractor. The Contractor shall also ensure that these materials are installed in the correct positions.

Where no Main Contractor is on site the Contractor is required to cover conduits installed in chases by a layer of 4 : 1 mixture of coarse sand and cement, finished 6mm below the face of the plaster and roughened. In all cases chases shall be deep enough to ensure that the top of conduits are at least 12mm below the finished plaster surface.

The Contractor is responsible for the cutting of chases and the building-in of conduits or other equipment. , He will be held responsible for all damage as a result of this work and will be required to make good to the satisfaction of the Engineer. Chases shall be made by means of a cutting machine.

Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer. Where it is necessary to cut or drill holes in the concrete structure, then prior permission of the Structural Engineer shall be obtained to ensure that the structure is not weakened.

The Contractor shall maintain close co-operation with the Main Contractor and all his Contractors throughout the course of the contract. Should the Contractor not comply with this requirements, any additional costs resulting from lack of his co-operation will be recovered from him.

E09.5.29 Connections to Switchboards

Wherever possible conduits connected to switchboards shall terminate in a common fabricated sheet steel draw box installed in the vicinity of the switchboard. In open roof spaces this draw box shall be placed in a roof space of not less than 900mm clearance. Lighting and plug circuits may be separately grouped in common conduits or metal ducts (trunking) from the distribution board to the draw box.

The draw box shall be of sheet steel with a minimum thickness of 1,6mm and shall be provided with a removable cover plate.

E09.5.29.1 Flush Mounted Switchboards

Where flush mounted switchboards are required, the recessed switchboard tray shall be built into the brick or concrete wall. All conduits from the floor or roof shall be fully recessed and shall be bonded directly to the tray.

E09.5.29.2 Surface Mounted Switchboards

Where surface mounted switchboards are specified but where the conduits can be fully recessed, the conduit shall be connected to a recessed connection box installed behind the switchboard. An opening with the same dimensions as the connection box shall be cut in the back of the switchboard and be provided with a suitable grommet.

E09.6 CABLE TRAYS AND LADDERS

Please revere to the specification E02: Electrical Cable Racks.

E09.7 WIRING DUCTS

E09.7.1 Responsibility of the Contractor

The Contractor shall supply and install all wiring ducts as specified or as required by the cable and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junction T-pieces end caps, etc.

E09.7.2 Materials and Finishes

Wiring ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

(a)	In boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations or other damp areas damp areas.	Stainless steel 3CR12 and epoxy powder coated
(b)	False ceiling voids	Pre-galvanised
(c)	Vertical building ducts	Hot-dipped galvanised to SANS 32 and SANS 121
(d)	Surface mounted in plant rooms, substations, service tunnels, basement, offices	Epoxy powder coated or electro-galvanised
(e)	Undercover industrial applications	Hot-dipped galvanised to SANS 32 and SANS 121.

The abovementioned finishes shall apply unless specifically to the contrary in the Detailed Technical Specification. Epoxy powder coats shall comply with paragraph EO9.12.9. Hot-dipped galvanised or electro-galvanised wiring ducts shall be cold galvanised at all joints, sections that have been cut and at places where galvanising has been damaged. Powder coated ducts shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturers of the channels.

E09.7.3 Cover Plates

All wiring ducts shall have metal snap-in cover plates. Cover plates for wider ducts shall be fixed by means of screws that shall permanently be tapped into the cover plates spaced at suitable intervals to prevent warping. The finish of the covers shall comply with paragraph EO9.7.2

E09.7.4 Connections

Adjoining lengths shall be correctly aligned and securely joined by means of fishplates and mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joint.

E09.7.5 Support for Conductors

All conductors in inverted wiring ducts shall be retained by means of metal clips or metal spacer bars at not less than 1m centres.

E09.7.6 Vermin Proofing

All wiring ducts shall be vermin proof after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips that are bolted or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

E09.7.7 Earth Continuity

Electrical and mechanical continuity shall be maintained throughout the wiring duct installation. A tinned copper bonding strip ($6mm^2$) shall be installed across each joint and secured to both adjoining ducts by means of galvanised bolts, nuts and washers. The duct shall be bonded to the earth bar of the associated switchboard.

E09.7.8 Internal Finishes

All bends shall be of easy sweep design with 45^o gussets. Burrs and sharp edges shall be removed and the inside edges of all joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent conductor insulation laceration.

E09.7.9 Services

Multiple duct runs or internal metal partitions shall be used where conductors for power, control and other services are present.

E09.7.10 Vertical Installation

Where vertical duct lengths exceed 5m, conductors shall have intermediate fixings.

E09.7.11 Number of Conductors

Wiring ducts shall be large enough to ensure that the combined total cross-sectional area (including insulation) of all conductors does not exceed 40% of the cross-sectional area of the duct.

E09.7.12 Fixing

The Contractor shall supply and install all hangers, supports or fixings for the ducts. Ducts up to 75 x 75mm shall be supported at maximum intervals of 1m and larger channels at maximum intervals of 2m. Duct runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. The method of fixing the ducts or supports to the structure shall comply with paragraph E09.4 with particular

reference to paragraphs E09.4.f and E09.4.h. Purpose made cable clamps, hangers, etc. shall be used as required.

E09.7.13 Installation in Concrete

The installation of wiring ducts in concrete will not be allowed.

E09.7.14 Fire Barrier

Where wiring ducts pass through walls, non-asbestos filling shall be installed around the conductors to serve as a fire barrier.

E09.7.15 Conduit Connection

All conduit connections shall be terminated by means of two lock nuts and a brass female bush. All holes through which conductors pass shall be equipped with grommets.

E09.8 INSTALLATION OF LUMINAIRES

E09.8.1 Positions

The mounting positions of luminaires shall be verified on site. All luminaires shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space. The layout as shown in the documents shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Engineer before commencing erection of the installation. Should the Contractor neglect to refer such discrepancies to the Engineer, costs incurred as a result of subsequent alterations to suit the architectural features shall be to the Contractor's account.

E09.8.2 Cover Plates

Cover plates shall be fitted over all draw boxes and outlets for luminaires that are not covered by the luminaire canopy, lamp-holder, ceiling rose or similar accessories.

E09.8.3 Hanger and Supports

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any fixing method approved by the Engineer.

E09.8.4 Suspended Cable Channels

Luminaires (especially fluorescent luminaires) may also be suspended from ceilings by means of suspended metal channels. The channel may be supported by conduits or threaded rods.

Should metal rods be utilised, these shall be screwed to anchor bolts fixed in the roof slab.

Wiring shall either be installed in conduits fixed to the metal channel or in the metal channels. Purpose-made clamps shall be used to fix the fittings to the cable channel.

E09.8.5 False Ceilings

In all cases where luminaires are fixed to false ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation.

Should any doubt exist in this regard, the matter shall be referred to the Engineer.

In cases where the mass of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.

E09.8.6 Fluorescent Luminaires Fixed to Concrete Slabs

Fluorescent luminaires to be installed directly against concrete slabs or walls shall be fixed to the outlet box and at two additional points. The additional fixing can be effected by:

(a) bolts built into the ceiling or wall,

(b) screws and approved plugs, or

(c) anchor bolts.

Shot-fired fixings are not acceptable. If specified or where approved by the Engineer, fluorescent fittings may be fixed to metal channels installed against concrete slabs or walls. The metal channel fixing may in this case be short-fired or fixed by any of the abovementioned methods. Purpose-made clamps shall be used to fix fittings to cable channels.

E09.8.7 Fluorescent Luminaires Fixed to False Ceilings

When fixing fluorescent luminaires to false ceilings, a gap shall not be visible, except where the ceiling tile is of non-fire resistant material, between the fitting and the ceiling. The luminaire shall be fixed directly to the ceiling beams by means of 40mm round-head wood screws and washer or alternatively be fixed to 50 x 76mm wooden supports that are fixed to the ceiling beams. In the case of tiled ceilings with exposed or concealed T-section supports, the luminaires shall be fixed to the metal supports by means of butterfly screws, pop-rivets or bolts with nuts and washers. Self-tapping screws may not be used.

E09.8.8 Continuous Rows of Luminaires

In cases where fluorescent luminaires are installed in tandem, only one connection outlet need be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and lock nuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the fitting canopies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at terminal blocks.

Screw connectors are not acceptable. The wiring for any other circuits or outlets, even though these may be in the same row may not be installed through the fitting canopies. The Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

E09.8.9 Recessed Luminaires

Where recessed luminaires are required, the Contractor shall maintain close liaison with the Ceiling Contractor. In the case of tiled ceilings, the luminaires shall be installed while the metal supports are being installed and before the tiles are placed in position. The Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles with the Main Contractor and the Ceiling Contractor concerned. All mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.

E09.8.10 Special Ceilings

In cases where special ceilings e.g. aluminium strips, decorative glass, metal leaves, etc., are to be installed, the Contractor and the manufacturer of the ceiling shall agree upon the method of fixing of luminaires to the ceiling.

E09.8.11 Waterproof Luminaires

Waterproof and flameproof luminaires shall be screwed directly to the conduit end. Draw boxes that may be required must be approved by the Engineer beforehand.

E09.8.12 Bulkhead Luminaires

Surface mounted bulkhead luminaires shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw box at the top or back of the fitting. The PVC-insulated conductors shall terminate in a porcelain terminal strip in the draw box. Asbestos or silicon-rubber insulated conductors shall be used from the terminal strip to the luminaire lamp-holder. Porcelain-screw connectors will also be allowed.

E09.9 INSTALLATION OF LIGHT SWITCHES

E09.9.1 Mounting

All light switches shall be installed 1400mm above the finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch.

E09.9.2 Doors

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall

be verified before the switch box is installed. Switch boxes in brick or concrete walls, shall be installed 150mm from the door frame. Light switches installed in partitions or door frames shall be of the type designed for that purpose.

E09.9.3 Walls

Where the lower portion of a wall is face brick and the upper portion plastered, light switches shall be installed wholly in the plaster, provided that the lower edge of the plaster is not higher than 1600mm above the finished floor level. In general where different wall finishes are used in the same area, switches shall be installed within the same finish and not on the dividing lines between finishes.

E09.9.4 Switch Boxes

Switches shall be installed in standard rustproof (galvanised) pressed steel switch boxes with the necessary knock-outs for the proper termination of conduits. The installation of switch boxes shall comply with the requirements of paragraph E09.5 of this specification. Boxes shall be flush mounted or recessed as specified for the whole installation.

E09.9.5 Cover Plates

Cover plates which overlap the switchbox and which fit tightly against the wall finishes shall be installed in the case of flush mounted switch-boxes. All fixing screws in cover plates and switch grids shall be supplied and securely fitted.

E09.9.6 Escutcheon Plates

Where flush mounted switches are installed in special wall finishes, e.g. wood or board panels, acoustic tiles or other cladding, etc., and where the wall finishes have to be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the switch box and shall be fixed independently of the switch box and cover plate. Bevelled cover plates that overlap the switch boxes shall be used. Cover plates shall be fixed to the switch boxes and shall fit firmly against the escutcheon plate.

E09.9.7 Surface Mounted Switches

Surface mounted switches shall consist of a metal switch-box, cover plate and switch specially manufactured for the purpose. Switch boxes shall be fixed to the surface as described in paragraph E09.4 of this specification.

E09.9.8 Cutting of Cover Plates

Cover plates shall under no circumstances be cut unless specifically authorised in exceptional cases by the Engineer.

E09.9.9 Partitions

Light switches installed in partitions shall preferably be of the type designed for this purpose to be accommodated in the partition design. Switches installed in the metal support do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

E09.9.10 Waterproof Switches

Switches that are exposed to the atmosphere or are installed in damp areas, shall be of the waterproof type.

E09.9.11 Appearance

The sides of adjacent switches, plugs, push-buttons, etc., shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be used for flush mounted outlets and accessories where the cover plates do not cover the cut-outs in the finishes.

E09.10 INSTALLATION OF SOCKET OUTLETS

E09.10.1 Mounting Heights

Unless otherwise specified socket outlets (flash or service mounted) shall be installed at the

following heights above finished floor level:

Socket outlets in general	300mm
Above working counter (kitchens, laboratories and prep areas)	1200mm
Shops	300mm
Offices	300mm

All mounting heights shall be measured from finished floor level to the centre of the outlet box Socket outlet boxes shall comply with paragraph E09.9.4.

E09.11 PROVISION FOR TELEPHONE INSTALLATION

E09.11.1 General

This specification covers only the supply and installation of outlet points and wiring channels and/or conduits for telephones in buildings. The telephone installation will be carried out by Telkom personnel or Specialist Contractor.

E09.11.2 Regulations

All provisions for telephones in buildings shall comply with the latest issue of "FACILITIES FOR TELECOMMUNICATION SERVICES IN BUILDINGS" as issued by Telkom. In cases where the provision of this publication and the requirements of the Detail Technical Specification are in conflict, the latter shall take precedence.

E09.11.3 Sleeves for Main Cables

One or more asbestos-cement or PVC sleeves as specified, shall be installed from a point at the boundary of the stand, (position indicated by the Engineer), to the main telephone distribution board or the main telephone building duct , 600mm below ground level.

A manhole with steel cover (as specified in Part 2, Detail specification) shall be installed at each bend in the underground route or at intervals not exceeding 50m in straight sections.

The inner radius of bends shall not be less than 12 times the outside diameter of the sleeves.

All sleeves, manhole covers and accessories shall be supplied by the Contractor including the building work of the manhole, unless specified to the contrary.

E09.11.4 Separation of Services

Cables or conductors for telephone services shall be separated from all other services by:

(a) Installation in separate metal channels or conduits, or

(b) Installing the cables at a minimum distance of 300mm from all power cables, conductors and accessories, or

(c) An earthed metal barrier installed to ensure that the minimum distance through free air space between the telephone cables and other services is at least 300mm.

Conduits or wiring channels installed for telephone services may not be used for any other purpose. Where non-metallic channels are used, the separation as stated in (b) above shall be maintained through the installation.

E09.11.5 Main Telephone Distribution Board

The size and position of the Main Telephone Distribution Board where required, shall be installed according to the requirements of the Detailed Technical Specification.

The board shall consist of a metal tray, architrave frame and hinged doors and shall be flush mounted in the position shown on the drawings.

A 20mm thick wooden panel shall be installed in the main telephone distribution board and shall cover the entire back of the board.

The finish of the board shall comply with the requirements of paragraph E09.16.9.

All conduits to telephone outlets or sub-distribution boards in the building as well as the main incoming sleeves, shall terminate at the main distribution board as indicated on the drawing.

Where 100 x 100 x 50mm draw boxes are specified, the boxes shall be provided with a cover plate. A wooden panel need not be provided in these cases.

E09.11.6 Telephone Outlets

The Contractor shall make provision for outlets with blank cover plates only.

Telephone outlets in walls shall consist of flush mounted 100 x 50 x 50mm draw boxes with blank cover plates.

Telephone outlets in floors shall be of the same type as floor outlets for power sockets which may be specified in the Detailed Technical Specification.

These provisions also apply to underfloor ducting. If no floor outlets are specified, 100 x 100 x 50mm flush mounted draw boxes with blank cover plates shall be provided in the floor at the positions indicated on the drawings.

Where twin underfloor ducts are provided and where the one duct is intended for telephone cables, the separation between the ducts shall be maintained throughout the underfloor ducting installation, including power outlets and telephone outlets.

Where power skirting is specified for telephone installations, the Contractor need only install the skirting with covers since the telephone socket outlet will be fixed directly to the cover.

Where multiple power skirting is provided containing other services, no other cables may be installed in the section intended for telephone cables and the separation between the sections shall be maintained throughout the installation.

E09.11.7 Connection of Telephone Outlets

Telephone outlets shall be inter-connected and connected to the telephone distribution boards as shown on the drawings.

If the inter-connecting conduits are not specified, conduit sizes shall be 25mm diameter for a maximum of 10 outlets and 32mm diameter for 11 to a maximum of 20 outlets.

Metal channels or power skirting installed on the same floor level on opposite walls of the same area as well as parallel runs of underfloor ducting intended for the installation of telephone cables, shall be inter-connected at intervals of 8 metres. Conduits may be used for these inter-connections.

All conduit and all ducts or channels which do not have removable covers, shall be provided with galvanised steel draw wires.

Conduit connections to power skirting or surface mounted metal channels, shall be made by means of a 100 x 100 x 50mm draw box which is flush mounted immediately behind the duct or channel in which the telephone cables are to be installed. A hole shall be cut in the back of the duct or channel, immediately opposite the draw box. The edges of the hole shall be grommetted. The draw box shall be accessible from the front when the cover is removed.

Purpose-made accessories for the connection of conduits to underfloor ducts shall be used. Where these are not available a 100 x 100 x 50mm draw box shall be installed below the underfloor duct opposite a floor telephone outlet. A hole shall be cut in the back of the duct opposite the draw box. The draw box shall be accessible from the top via the floor outlet.

E09.12 SWITCHBOARDS AND DISTRIBUTION BOARDS

Please see Specification E04: Electrical Low Voltage Distribution Boards and Motor Control Centres.

E09.13 NOISE AND VIBRATION

If in the opinion of the Engineer, any equipment operates with, or transmits from it, objectionable noise or vibration, it will be necessary to rectify or replace such plant in order

that the system operates at conditions acceptable to the Engineer. Remedial measures taken to achieve satisfactory noise and vibration levels shall be at no additional cost to the Employer.

The following measures shall be taken where necessary, whether specifically stipulated in these documents or not, all to ensure quiet, vibration-free operation of the installations:

(a) Equipment shall be mounted on vibration isolators of the correct type and selection, dependent upon deflection requirements versus vibrating frequency.

(b) Pipework and ductwork shall be suspended or mounted using suitable supports with vibration isolators to prevent transmission of vibration from them to the structure to which they are attached.

E09.14 COMMISSIONING AND TESTING

The Contractor shall commission and test the entire installation at his own expense, including provision of all test equipment, such testing to be done in the presence of the Engineer, who shall have been notified of the dates and approximate duration of the tests sufficiently early to allow him to witness tests if necessary.

The Contractor shall properly test and call for inspection by the Engineer any work which is to be covered, concealed, built-in, otherwise closed up or rendered inaccessible, before such closing up takes place. The Engineer may require any work of this nature which he has not been called on to inspect before closing up, to be uncovered or made accessible to him entirely at the Contractor's expense, making good included.

It is in the interest of the Contractor to notify the Engineer when the installation reaches various stages of completion (e.g. before plastering, final finishes, before casting concrete, etc) in order that the Engineer may inspect the installation and point out discrepancies. These inspections shall be considered informal and under no circumstances will they, in part or in whole, invalidate the requirements of the document. Any costs incurred in correcting discrepancies shall be to the Contractor's account.

The Contractor shall keep full and proper written records of all tests conducted and commissioning information, such data to be properly indexed and submitted to the Engineer for his records.

The Contractor shall test electrical wiring for compliance with regulations and have the complete installation tested by the relevant authorities.

The Engineer reserves the right to inspect any item of equipment during manufacture or before delivery to site. The Contractor shall make available any item for such inspection. The Engineer shall also be furnished with manufacturer's test certificates whenever these are required by law or called for by the Engineer.

The Contractor shall commission the complete installation prior to inviting the Engineer to accept it, commissioning including inter alia the following services, as relevant:

(a) The Contractor shall record all motor running currents and set overload protection devices to correct values.

(b) The Contractor shall adjust and set all time clocks, time delay relays, automatic control devices and check their function for correctness and response.

(c) The Contractor shall remedy any defects apparent on the installation prior to calling upon the Engineer to accept the plants.

Thermal images of the panels and distribution board must be taken once the units are more than one week in operation. The images must be taken while in normal operating condition. The images should be reviewed and then presented as part of the Operations and maintenance manuals.

E09.15 LABELLING AND IDENTIFICATION

All equipment shall be labelled and identified using white trifoliate labels having black lettering engraved on them; where two similar items exist, they shall additionally be numbered for clarity in identification.

Labels shall be secured by means of white rivets, slotted label holders or screwed on. Self-tapping screws will not be allowed.

All other equipment including metres, instruments, indicator lights, switches, push-buttons, circuit breakers, fuses, etc., shall be identified. The function of the equipment and circuits shall be clearly identified. Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively.

E09.16 OPERATING AND MAINTENANCE MANUALS; "AS BUILT" OR "AS INSTALLED" RECORD DRAWINGS

Provide three hard copies and one disk of all operating and maintenance manuals and record drawings.

Provide a MSWORD for WINDOWS disk copy for any word processed elements of the operating and maintenance manuals. Employ a specialist to prepare manuals for the form and content of the operating and maintenance manuals.

Agree format and contents with the Employer Operating and maintenance manuals must include, but are not limited to the following:

- Index of Contents
- A full description of each of the systems installed, written to ensure that the Employer's staff fully understand the scope and facilities provided. Description to include data on general design parameters, normal associated operating conditions and manufacturer's information concerning correct operation, etc., based on commissioning results.
- A description of the mode of operation of all systems.
- **Diagrammatic** drawings to each system (including distribution boards) indicating principal items of plant, equipment, valves, etc.
- A photo-reduction of all record drawings, together with an index.
  Size A4
  Size A3
- Legend for all colour-coded services.
- Schedules (system by system) of plant, equipment, valves, etc., stating their locations within the building, duties and performance figures. Ensure each item has a unique code number cross-referenced to the record and diagrammatic drawings and schedules.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list and order acknowledgement numbers.
- Manufacturer's technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
- A copy for all Test Certificates, Certificates of Compliance, Inspection and Test Records, Commissioning and Performance Test Records (including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests) for the installations and plant, equipment, valves, etc., used in the installations.
- A copy of all manufacturers' guarantees or warranties.
- Copies of Insurance and Inspecting Authority Certificates and Reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Details of procedures to maintain plant in safe working conditions.
- Control sequences for all systems installed.
- Schedule of all fixed and variable equipment settings established during commissioning.
- Back-up copies of any system software.
- Documentation of the procedures for updating and/or modifying software operating systems and control programs.

- Instructions for the creation of Control procedure routines and Graphic diagrams
- Details of the software revision for all programs provided.
- Two back-up copies of all software items, as commissioned.
- Details of lubrication systems and lubrication schedules for all lubricated items.
- A list of normal consumable items.
- A list of recommended maintenance spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
- A list of any special tools needed for maintenance cross referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Copies of all items incorporated in the plant room and switch room schedules and schematics.
- Encase the Manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover-titled. Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.
- Provide record drawings. Include the provision of relevant framed plasticised drawings in all electrical rooms.
- Three copies of all “AS BUILT” or “AS INSTALLED” record drawings, in print form, are required to be handed to the Engineer before completion of the project. There shall have been previously submitted to the Electrical Engineer for comment and approval. The Electrical Engineer also requires 2 copies of all record drawings to be made available on disk on CAD format. All “AS BUILT” or “AS INSTALLED” record drawings are to be prepared by the Electrical contractor in CAD format.

E09.17 TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

The contractor shall carry out all the tests for the Main distribution board and will also conduct all tests and complete copies of the tests for each distribution board and for each supply (normal and alternative supplies), and attach as annexes to the completion report. The tests required will be the following as a minimum:

(a) Continuity of bonding
(b) Resistance of earth continuity conductor
(c) Continuity of ring circuits (if applicable)
(d) Earth loop impedance test
(e) Elevated voltage between incoming neutral and external earth (ground)
(f) Earth resistance at electrode (if required)
(g) Insulation resistance MΩ
(h) Voltage at main distribution board with no load for each phase to neutral
(i) Voltage at main distribution board with load (as calculated for full load) for each phase to neutral V
(j) Voltage at available load (worst condition as calculated for full load) for each phase to neutral
(k) Operation of all earth leakage units
(l) Operation of all earth leakage test buttons

(m) Polarity of points of consumption
(n) Phase rotation at points of consumption for three-phase systems
(o) All switching devices, make-and-break circuits

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

(a) The Occupational Health and Safety Act (OHSA) 1994;

(b) The requirements of the Local and Supply Authorities.

E09.18 MAINTENANCE INSTRUCTIONS AND GUARANTEES

Retain copies of all maintenance instructions and guarantees delivered with components and equipment (failing which, obtain), register with manufacturer as necessary and handover to the Employer on or before Practical Completion. Notify the Employer of telephone numbers for emergency services by Specialist Contractors and Suppliers after Practical Completion.

E09.19 MEASUREMENT AND PAYMENT

Item ..... **Unit**

Supply and deliver distribution boards ..... No

The unit of measurement shall be the number of distribution boards supplied and installed. The tendered rate shall include full compensation for the supply and delivery of the distribution board as specified in the detail specification complete with all the electrical equipment specified.

Item ..... **Unit**

Install, test and commission the distribution boards..... No

The unit of measurement shall be the number of distribution boards installed, tested and commissioned. The tendered rate shall include full compensation for the installing, testing and commissioning of the distribution boards complete with all the specified electrical equipment in the distribution board. The tendered rate shall furthermore include for the wiring of the distribution board.

Item ..... **Unit**

Supply and deliver isolators..... No

The unit of measurement shall be the number of isolators supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the isolators where the isolators are specified separately.

Item ..... **Unit**

Install isolators ..... No

The unit of measurement shall be the number of isolators installed.

The tendered rate shall include full compensation for the installing of the isolators where the isolators are specified separately.

Item ..... **Unit**

Supply and deliver circuit breakers ..... No

The unit of measurement shall be the number of circuit breakers supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breakers where the circuit breakers are specified separately.

Item ..... **Unit**

Install circuit breakers ..... No

The unit of measurement shall be the number of circuit breakers installed.

The tendered rate shall include full compensation for the installing of the circuit breakers where the circuit breakers are specified separately.

Item ..... **Unit**

Supply and deliver fuse switches ..... No

The unit of measurement shall be the number of fuse switches supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the fuse switches where the fuse switches are specified separately.

Item ..... **Unit**

Install fuse switches ..... No

The unit of measurement shall be the number of fuse switches installed.

The tendered rate shall include full compensation for the installing of the fuse switches where the fuse switches are specified separately.

Item ..... **Unit**

Supply and deliver earth leakage units ..... No

The unit of measurement shall be the number of earth leakage units supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item ..... **Unit**

Install earth leakage units ..... No

The unit of measurement shall be the number of earth leakage units installed.

The tendered rate shall include full compensation for the installing of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item ..... **Unit**

Supply and deliver contactors ..... No

The unit of measurement shall be the number of contactors supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the contactors where the contactors are specified separately.

Item ..... **Unit**

Install contactors ..... No

The unit of measurement shall be the number of contactors installed.

The tendered rate shall include full compensation for the installing of the contactors where the contactors are specified separately.

Item ..... **Unit**

Supply and deliver light fittings ..... No

The tendered rate shall include full compensation for the supply and delivery to site of the specified light fitting, complete with lamp/s, wiring, control gear where applicable, diffusers, etc.

Separate items shall be scheduled for each type of light fitting required.

Item ..... **Unit**

Install light fittings ..... No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting and testing of the light fitting.

Separate items shall be scheduled for each type of light fitting. This rate shall furthermore include full compensation for the cost of providing and installing all hardware, timber backing, plugs, screws connector terminals and other materials required to install the light fitting in accordance with the specification.

Item ..... **Unit**

Supply and deliver switches ..... No

The tendered rate shall include full compensation for the supply and delivery to site of the specified switch complete with cover plate and fastening screws.

Separate items shall be scheduled for each type of switch.

Item ..... **Unit**

Install switches ..... No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting, fitting of cover plate and testing of the switch.

Separate items shall be scheduled for each type of switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware screws and wall plugs in the case of surface mounted switches, required to install the switch in accordance with the specification.

Item ..... **Unit**

Supply and deliver photo-electric switch ..... No

The tendered rate shall include full compensation for the supply and delivery to site of the specified photo-electric daylight switch complete with mounting bracket and around bulkhead light enclosure.

Item ..... **Unit**

Install photo-electric switch ..... No

The tendered rate shall include full compensation for the handling, inspection, fastening of the bulkhead enclosure and photo electric switch, connecting and testing of the switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware, screws, wall plugs and other material required to install the photo electric light switch in accordance with the specification.

Item ..... **Unit**

Supply lighting track ..... m

The unit of measurement shall be the linear metre of track supplied.

The tendered rate shall include the supply and delivery to site of the track as specified in the detail specification.

Item ..... **Unit**

Install lighting track ..... m

The unit of measurement shall be the linear metre of lighting track installed.

The tendered rate shall include full compensation for cutting to size and fixing to the ceiling or wall with appropriate fasteners of the lighting track and shall include the wiring connections of the supply circuit.

Item ..... **Unit**

Supply and install lighting track accessories ..... No

The unit of measurement shall be the number of splices, bends, elbows, connector units and end caps.

The tendered rate shall include full compensation for the supply, connecting, installation and fixing of accessories as detailed in the schedule of quantities.

Item ..... **Unit**

Supply consumer distribution kiosks ..... No

The unit of measurement shall be the number of distribution kiosk supplied.

The rate shall include full compensation for the supply of the distribution kiosks complete as specified.

Item ..... **Unit**

Install consumer distribution kiosks ..... No

The unit of measurement shall be the number of distribution kiosks installed.

The rate shall cover the cost of the sitting, handling, transporting, installing, painting, testing and commissioning of each kiosk.

Item ..... **Unit**

Supply and erect concrete plinths for consumer distribution kiosks ..... No

The unit of measurement shall be the number of plinths supplied and erected.

The rate shall include full compensation for the supply of precast plinths and bases and the erection thereof as specified.

Item ..... **Unit**

Supply consumer distribution pillars ..... No

The unit of measurement shall be the number of distribution pillars supplied.

The rate shall include full compensation for the supply of the distribution pillars fully equipped as specified.

Item ..... **Unit**

Install consumer distribution pillars ..... No

The unit of measurement shall be the number of distribution pillars installed.

The rate shall include full compensation for the installing of the distribution pillars and shall include for the excavation for the installing of the pillar and the backfilling, compacting and disposal of the surplus material once the pillar has been installed.

Item ..... **Unit**

Supply service connection cable ..... m

The unit of measurement shall be the length in metres of service connection cables supplied.

The tendered rate shall include full compensation for the supply and delivery of the cable to site.

Item ..... **Unit**

Lay service connection cable ..... m

The unit of measurement shall be the length in metres of service connection cable laid.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables will be measured linearly over all lengths laid.

Item ..... **Unit**

Terminate service connection cable ..... No

The unit of measurement shall be the number of service connection cable terminated.

The tendered rate shall include full compensation for the termination cable including all material and labour to render complete terminations of the cables.

Item ..... **Unit**

Supply socket outlets..... No

The unit of measurement shall be the number of socket outlets supplied.

The tendered rate shall include full compensation for the supply and delivery of single or double single phase, three pin socket outlets.

Separate items shall be scheduled for the following:

(a) socket outlets flush mounted

(b) socket outlets surface mounted

(c) socket outlets to be installed in power skirting

(d) socket outlets to be installed in pedestals for floor ducting

(e) socket outlets to be installed in recessed service outlets for floor ducting.

Separate items shall be scheduled for standard and dedicated switched socket outlets. All socket outlets shall be supplied complete with cover plates and boxes where required. The tendered rate shall therefore include for the supply of the cover plates and fixing screws where applicable.

Item ..... **Unit**

Install socket outlets ..... No

The unit of measurement shall be the number of socket outlets installed.

The tendered rate shall include full compensation for the installing of the socket outlets. Separate items will be scheduled for the various type of socket outlets specified in item 6.6.8. The tendered rate shall furthermore include for the installing of the cover plates where applicable.

Item ..... **Unit**

Supply plug tops for dedicated socket outlets ..... No

The unit of measurement shall be the number of plug tops supplied.

The tendered rate shall include full compensation for the supply of plug tops for each of the dedicated socket outlets supplied and installed under this contract.

Item ..... **Unit**

Supply and deliver double pole isolator for geyser supply ..... No

The unit of measurement shall be the number of double pole isolators supplied.

The tendered rate shall include full compensation for the supply and delivery of double pole isolators for the geyser supplies.

Item ..... **Unit**

Install double pole isolator for geyser supply..... No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installing of double pole isolators for the geyser supplies.

Item ..... **Unit**

Supply and install connections to heaters, stoves, fans and air conditioners units ..... No

The unit of measurement shall be the number of connections made.

The tendered rate shall include full compensation for the installing of the connections to the heaters, stoves, fans and air conditioners and shall include for the supply and installing of the

double pole isolator or control unit which ever is applicable.

Separate items shall be scheduled for each type of connections.

Item ..... **Unit**

Supply double pole isolators for power skirting..... No

The unit of measurement shall be the number of double pole isolators supplied for the power skirting.

The tendered rate shall include full compensation for the supply and delivery to site of the double pole isolators.

Item ..... **Unit**

Install double pole isolators for power skirting ..... No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installation of the double pole isolators in the power skirting and shall include the connections of the conductors to the isolators.

Item ..... **Unit**

Supply junction boxes..... No

The unit of measurement shall be the number of junction boxes supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the junction boxes.

Separate items shall be scheduled for each type of junction box.

Item ..... **Unit**

Install junction boxes ..... No

The unit of measurement shall be the number of junction boxes installed.

The tendered rate shall include full compensation for the installation of the junction boxes as specified.

Separate items shall be scheduled for each type of junction box.

Item ..... **Unit**

Supply and delivery of conduit .....m

The unit of measurement shall be the linear metre of conduit supplied and delivered.

The tendered rate shall include for full compensation for the supply and delivery of the specified conduit and shall include full compensation for the supply of the couplings to join the conducts. Separate items shall be scheduled for the different types of conduit specified.

Item ..... **Unit**

Installing of conduit.....m

The unit of measurement shall be the linear metre of conduit installed.

The tendered rate shall include for full compensation for the installing of the conduit including jointing and bending the conduit and fixing the conduit using saddles as specified. Separate items shall be scheduled for the different types of conduit and for installing the conduit in concrete, fixing the conduit in brick work, including the chasing thereof, fixing the conduit on the surface of structures or installing the conduit in ceiling voids.

Item ..... **Unit**

Terminate conduit..... No

The unit of measurement shall be the number of terminations made.

The tendered rate shall include full compensation for terminating the conduit in draw boxes and outlet boxes and shall include for all locknuts and bushes.

Item ..... **Unit**

Supply and install draw boxes ..... No

The unit of measurement shall be the number of draw boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing the draw boxes including the cover plates. Separate items shall be scheduled for installing the boxes in concrete, in brickwork including chasing, and on the surface of structures.

Item ..... **Unit**

Supply and install conduit outlet boxes ..... No

The unit of measurement shall be the number of conduit outlet boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing conduit outlet boxes and shall include blank cover plates where no equipment is installed in the boxes. Separate items shall be scheduled for 1, 2, 3 and 4 way outlet boxes and for installing the boxes in concrete, in brick walls, including the chasing thereof, and surface on structures.

Item ..... **Unit**

Supply power skirting .....m

The unit of measurement shall be the linear metre of power skirting supplied.

The tendered rate shall include full compensation for the specified power skirting including cover plates. Separate items shall be scheduled for one, two and three compartment power skirting.

Item ..... **Unit**

Install power skirting.....m

The unit of measurement shall be the linear metre of power skirting installed.

The tendered rate shall include full compensation for installing the power skirting including all material required to install the power skirting.

Item ..... **Unit**

Supply and install power skirting end caps, bends, conduit outlets & accessories ..... No

The unit of measurement shall be the number of power skirting end caps, bends and conduit outlets supplied and installed.

The tendered rate shall include full compensation for the supply and installing of the power skirting end caps, internal and external bends and outlets and shall include for the supply of all material required to complete the installing thereof.

Item ..... **Unit**

Supply under floor ducting.....m

The unit of measurement shall be the linear metre of under floor ducting supplied.

The tendered rate shall include full compensation for the supply of under floor ducting. Separate items shall be scheduled for the two and three compartment ducting.

Item ..... **Unit**

Supply under floor ducting accessories..... No

The unit of measurement shall be the number of accessories supplied.

The tendered rate shall include full compensation for the supply of the required accessories for the completion of the under floor installation. Separate rates shall be scheduled for cross-over, T-junction and right angle bend draw boxes and up-bends.

Item ..... **Unit**

Supply pedestal units ..... No

The unit of measurement shall be the number of pedestals supplied.

The tendered rate shall include full compensation for the supply of the specified pedestal units.

Item ..... **Unit**

Install under floor ducting..... m

The unit of measurement shall be the linear metre of ducting installed.

The tendered rate shall include full compensation for the installation of the under floor ducting.

Item ..... **Unit**

Install under floor ducting accessories ..... No

The unit of measurement shall be the number of accessories installed.

The tendered rate shall include full compensation for the installation of the accessories. Separate items shall be scheduled for the cross-over, T-junction and right angle bend draw boxes and up-bends.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E11 : ELECTRICAL EARTHING AND LIGHTING PROTECTION

Johannesburg Water

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 5

August 2019

a world class African city

City of Johannesburg
Johannesburg Water SOC Ltd

17 Harrison Street
Johannesburg

Johannesburg Water
PO Box 61542
Marshalltown
2107

Tel +27(0) 11 688 1400
Fax +27(0) 11 688 1528

www.johannesburgwater.co.za

PARTICULAR SPECIFICATION

M20: MECHANICAL VALVES: MANUFACTURE AND SUPPLY

4	2013-10-23	Minor updates and re-issued	J Ritchie	
3	2012-07-30	General review	T Wellard	
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

PARTICULAR SPECIFICATION M20: MECHANICAL VALVES: MANUFACTURE AND SUPPLY

CONTENTS

M20.1 SCOPE 3

M20.2 INTERPRETATIONS 3
M20.2.1 Abbreviations 3
M20.2.2 Standards 3
M20.2.3 General Requirements 4

M20.3 GENERAL REQUIREMENTS 4
M20.3.1 Pressure Rating 4
M20.3.2 Wastewater Liquids and chemicals 4
M20.3.3 Guarantee 4
M20.3.4 Operating and Maintenance Manuals 4
M20.3.5 Jointing Material 5
M20.3.6 Contact between Dissimilar Metals 5

M20.4 FABRICATION 5
M20.4.1 General 5

M20.5 BUTTERFLY VALVES 6
M20.5.1 Opening and Closing 6
M20.5.2 Valve Body 6
M20.5.3 Discs 7
M20.5.4 Seats and Seals 7
M20.5.5 Shafts 7
M20.5.6 Bearings 7
M20.5.7 Gearboxes 7

M20.6 AIR RELEASE VALVES 8
M20.6.1 Water works anti-shock and air release 8
M20.6.2 Air Valves (Sewage) 8
M20.6.3 Air Valves (Water Mains) 8
M20.6.4 Special Valves 9

M20.7 GATE VALVES 9
M20.7.1 Wedge Gate Valves 9
M20.7.2 Knife Gate Valves 10
M20.7.3 Resilient Seal Valves 10

M20.8 NEEDLE VALVES 10

M20.9 SPECIAL VALVES 10

M20.10 REFLUX/NON RETURN VALVES 11

M20.11 DIAPHRAGM VALVES 11

M20.12 BALL VALVES 11
M20.12.1 Type BLV1 11
M20.12.2 Type BLV2 12
M20.12.3 Valve Body 12

M20.13 PRESSURE REDUCING VALVE ANGLE/GLOBE PATTERN TYPE 12
M20.13.1 Main Valve 12
M20.13.2 Main Valve Body 12
M20.13.3 Material Specification 13
M20.13.4 Pilot Control System 14
M20.13.5 Material Specification for Pilot Control 14

M20.14 PRESSURE REDUCING VALVE (SINGLE DIAPHRAGM LINER-OPERATED TYPE) 14
M20.14.1 Function 14
M20.14.2 Main Valve 14
M20.14.3 Material Specification 14
M20.14.4 Pilot Control System 15
M20.14.5 Material Specification for Pilot Control 15

M20.15 FLOW LIMITER VALVES 15
M20.15.1 Screwed type limiter valves 15
M20.15.2 Wafer type limiter valves 16

M20.16 VALVE GEARBOXES 17

M20.17 PROTECTION OF VALVES 17

M20.18 TOLERANCES 18

M20.19 COLOUR CODES 18

M20.20 TESTING AND INSPECTION 18
M20.20.1 Testing by Manufacturer 18
M20.20.2 Testing by Independent Body 18
M20.20.3 Inspection 18
M20.20.4 Hydrostatic Testing 18

M20.21 MEASUREMENT AND PAYMENT 18

M20.1 SCOPE

This Specification covers the manufacture, testing and supply of sluice, butterfly, air, gate, reflux, diaphragm, flow limiter and pressure reducing valves for use in pressure pipelines for the conveyance of raw or potable water at ambient temperatures.

M20.2 INTERPRETATIONS

M20.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
DIN	:	Deutsch Industry Normen
ISO	:	International Organisation for Standardization
ASME	:	American Society of Mechanical Engineers
SAECC	:	South African Electrolytic Corrosion Committee

M20.2.2 Standards

For the purposes of this Specification the latest issues of the following standard specifications will apply:-

SANS 1700	:	Fasteners
SANS 135	:	Isometric Bold Screws and Nuts (Lexagon & square/coarse thread free fit series)
SANS 136	:	Isometric Precision Hexagon Head Bolts and Screws and Hexagon Nuts (coarse thread medium fit series)
SANS 144	:	Cast Iron Single-door Reflux Valves
SANS 191	:	Cast Steel Gate Valves
SANS 192	:	Cast Steel Single-door Reflux Valves
SANS 664	:	Cast Iron Gate Valves for Waterworks and heavy Industrial Purposes
SANS 936	:	Cast Iron Spheroidal Graphite Iron Castings
SANS 1431	:	Steel
BS 3100	:	Cast Steel
BS 4504	:	Flange Drilling
BS 5155	:	Cast Iron and Carbon Steel Butterfly Valves
SIS 05 59 00	:	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ISO 2441	:	Pipe Line Flanges for General use - Shapes and Dimensions of Pressure Tight Surfaces
SANS 1123	:	Steel Pipe Flanges

M20.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M20.3 GENERAL REQUIREMENTS

Satisfactory temporary end cover shall be provided to protect threads, flanges and prepared ends of valves from damage during transportation and handling on site.

Valves shall be so transported, stored and handled as to prevent damage. Valves damaged in any way shall be removed from the site.

The Contractor shall satisfy the Engineer as to the sufficiency of the place of manufacture regarding manufacturing, testing and inspection equipment to ensure that the production of valves is strictly in accordance with this Specification.

M20.3.1 Pressure Rating

The design pressure for the valve is specified in the Tender Document either in/or the Project Specification, Drawings and Schedule of Quantities. The minimum pressure rating for valves shall be 10 Bar. Valves shall be capable of withstanding the applicable test pressure as specified in SABS 664. Test pressure shall be maintained for 5 minutes and the valve bodies shall be watertight in all aspects.

M20.3.2 Wastewater Liquids and chemicals

Various different chemicals are used to treat wastewater. These include:-

- Ferric chloride
- Chlorine
- Polymer (Polyelectrolytes)
- Ammonium bromide

Valves used for the above mentioned chemicals shall be manufactured from highly non-reactive polymer such as Polyvinylidene Fluoride (PVDF) and PVC.

Valves which encounter raw wastewater, treated wastewater and sludge shall be manufactured from corrosive resistant material.

M20.3.3 Guarantee

All valves shall be guaranteed against faulty design, materials and workmanship until the end of the maintenance period on the Main Contract. During this period the Contractor shall be required to attend to and rectify any defects, which occur due to faulty design, materials or workmanship at his own cost.

M20.3.4 Operating and Maintenance Manuals

A copy of the Operating and Maintenance Manual for each valve type and different valve manufactures shall be bound in with the Operating and Maintenance Manual for the project. The manual shall be A4 size and properly bound. Drawings larger than A3 size shall be contained in separate plastic pockets.

M20.3.4.1 Contents

- A copy of the signed factory test certificate shall be bound in with the manual, while the original shall be handed to the Engineer.
- Operating instructions
- Maintenance instructions
- Lubrication instructions
- Spare parts list
- Drawings
- Brochures

M20.3.5 Jointing Material

Jointing material shall comply with SANS 1700. Valves shall be supplied complete with bolts, nuts, washers (2 per bolt) and gaskets for joining up to adjacent mating flanges.

Bolts shall be of stainless steel in all open applications (e.g. in valve chambers, reservoirs, etc.) and galvanised when buried provided the flanges are protected with DENSO mastic and tape. The bolt shall be long enough to allow at least two screw threads to protrude from the nut when the assembly is fully tightened. A washer must be provided both under the bolt head and the nut.

M20.3.6 Contact between Dissimilar Metals

When flanges of dissimilar metals are bolted together, the internal epoxy coating shall cover the contact area of the flange without any break.

Suitable insulation material shall be used between the contact faces of dissimilar metals of which the potential difference exceeds 0,3 V. Where corrodible metal is welded to a corrosion resistant metal, the protection coating specified shall overlap onto the latter by at least 5 mm.

M20.4 FABRICATION

M20.4.1 General

(a) Marking of Valves

The design pressure in Mpa shall be hard stamped on the edge of flanges to valves, to be visible from the top of valves.

(b) By-passes

Where indicated in the Project Specification or the Schedule of Quantities, valves shall be supplied with by-passes. Such by-passes shall be bolted on to the body of the valve and not to the adjoining pipework.

(c) Hand wheels and Direction of Closure

Where valves are required to be supplied with hand wheels, the rims of such hand wheels shall be machined to a smooth finish if specified. Arrows shall be cast on the hand wheels together with the wording "TO OPEN" or "TO CLOSE" - Closing being by the clockwise rotation of the spindle unless otherwise specified.

(d) For cap top valves an aluminium disc of at least 100 mm diameter with the same wording and arrows shall be slipped over the spindle and retained by the cap.

If specified in the Project Specification, valves shall be fitted with indicators representing

the valve status, showing fully open, fully closed and intermediate positions. Such indicators shall be corrosive proof and of robust design.

(e) Flanges

Unless otherwise indicated flanges shall conform, in all respects, to the requirements of SANS 1123 appropriate for the class of valve specified.

Should required sizes fall beyond the range of SANS 1123, flange dimensions shall confirm to the requirements as specified.

The Contractor shall obtain written confirmation of required flange drilling from the Engineer prior to the commencement of manufacture.

Sufficient clearance shall be allowed between the body of the valve and the flange to enable proper tightening of bolts. Tapped holes shall only be allowed in exceptional cases and with the Engineer's written consent.

(f) Information to be Supplied

Complete details of each valve offered must be provided at the time of tendering. This information will include at least the following:-

- Description
- Manufacturer's figure number
- Flange drilling
- Maximum working pressure (in kPa)
- Maximum unbalanced pressure (in kPa)
- Test pressure (in kPa)
- Material of components
- Gearing
- Accessories

M20.5 BUTTERFLY VALVES

Butterfly Valves shall be of the full-bore type and NOT reduced bore type with flanged ends. Valves larger than 200mm shall be fitted with gearboxes.

M20.5.1 Opening and Closing

All valves shall be capable of being opened or closed by hand under an unbalanced pressure equal to the design pressure without any difficulty. The disc shall close with a positive action with no possibility of slamming shut during any stage of the closing operation and the valve shall be capable of operating at any opening without variation of disc position or flutter of the disc.

The direction of the spindle rotation for valve closing shall be clockwise.

M20.5.2 Valve Body

Valve bodies shall be manufactured from cast iron or cast steel depending on test pressures and as specified.

The valve body shall have integral hubs for shaft bearing housings. Valves shall be provided with supporting feet and lifting rings where specified. A flow direction arrow shall either be cast into the body or shall be a brass plate screwed onto the body with brass screws.

M20.5.3 Discs

Discs shall be manufactured from cast iron or cast steel depending on test pressures and as specified. Discs shall be a single casting having a smooth streamlined design to minimize resistance to water flow.

The disc shall be off-set in the body to ensure simultaneous contact around its perimeter and shall have a positive non-slamming closing action.

M20.5.4 Seats and Seals

The profiles of the seats shall be smooth and continuous and shall provide adequate “lead in” for the resilient seal during closure of the disc to prevent excessive seating torque requirements. The seats shall be fixed to the valve body with stainless steel countersunk screws to facilitate replacement.

The seals shall be of the resilient type with non-weathering, non-sticking, long life properties. Seals shall be replaceable and shall be secured to the edge of the disc by means of a retaining ring. Sealing rings and seal retaining rings shall be manufactured from stainless steel.

The design of the seat and seal shall allow replacement thereof without removing the valve from the line.

M20.5.5 Shafts

Valve shafts shall be of high grade stainless steel. Valve shafts shall either be continuous through the disc or of a stub shaft design as described in the Project Specification and will be horizontal to the installed valve position. In the case of the sub-shaft type, each stub shaft shall extend into the disc hub for a distance of at least 1.5 times the shaft diameter.

All keys, dowel pins and taper pins used to attach the shaft to the disc shall be mechanically secured. The shaft shall be so sealed that the only two wetted parts shall be the disc and the seat.

M20.5.6 Bearings

Class 16 (1600 kPa) valves or valves with diameters of 350 mm or bigger shall be fitted with two-way adjustable bearings in order to permit precise disc-to-seat positioning at all times.

Positive bearing retention shall also be provided so that the bearing will not shift under operating conditions. The valve shall be capable of being installed and operated in any position.

The bearings shall be self-lubricating, long lasting sleeve-type bearings shall be fitted in the hubs of the valve body and at least one set of thrust bearings shall be provided.

M20.5.7 Gearboxes

Where it is necessary or where it is specified valves shall be operated via manually operated gearboxes

Gearboxes shall be self-locking and capable of holding the disc in a fixed position for any extended period of time.

Gearboxes shall be geared to be operated against the maximum unbalanced pressure with an effort not exceeding 200 N with each hand on the rim of a standard hand wheel. (Total effort = 400 N).

Gearboxes shall also be fitted with mechanical stops to prevent excessive turning and shall be

provided with replaceable shear pins. One spare shear pin shall be provided with each valve.

All gearboxes shall be equipped with position indicators, adjustable travel stops and indications of the "open" and "closed" positions.

The design of the gearbox shall readily allow for conversion to motorised drive at a later stage if required.

M20.6 AIR RELEASE VALVES

M20.6.1 Water works anti-shock and air release

Air valves shall be manufactured from cast iron or stainless steel depending on the test pressures and the project specification and of the single chamber design with cylindrical solid polymer control floats incorporating anti-shock design during high velocity air discharge.

The orifice plate, internals and body bolts shall be of stainless steel. All components of the valve shall be easily replaceable. All internals made of stainless steel that will be in contact with the fluid shall be lined or coated with a polyurethane paint to prevent cathodic action.

The design of the valve shall be such as to preclude the loss of water or the possibility of the float being blown shut by the passage of air when the accumulation of air in the pipeline is being released.

The valves shall be positive in the action to admit a free and full supply of air when the pipeline is being emptied or when the operating conditions demand.

Valves shall respond to the presence of accumulated air under normal working conditions by discharging it through a small orifice at any pressures within the specified design range.

Valves shall react immediately to pipeline drainage by full opening of the large orifice to allow unrestricted air intake. Valves shall not exhibit leaks or weeping past the large orifice seal at the maximum working pressure.

M20.6.2 Air Valves (Sewage)

Where air valves are required on sewage or industrial effluent pumping mains, they shall be specifically designed for such usage. Ordinary waterworks pattern air valves will not be acceptable.

Air valves shall be installed with an isolating valve on the inlet.

Full details of the air valves offered shall be provided at the time of tendering.

M20.6.3 Air Valves (Water Mains)

The following types of air valves as indicated on the Drawings and/or listed in the Schedule of Quantities are required.-

Type SO : Small orifice, single ball, lever type air valve which permits the escape of air from the pipe under working pressure.

Type LO : Large orifice, single ball air valve which allow air to enter the pipe when the pipe is being emptied and permit air to escape from the pipe when it is being filled.

Type DO : A combined small and large orifice air valve, the small orifice operating as the type SO and the large orifice as type LO above.

The size of the air valve shall be specified on the Drawings or in the Schedule of Quantities by the inlet diameter.

Air valves shall be suitable for the working pressure indicated on the Drawings or stated in the Schedule of Quantities.

All air valves shall be flanged and fitted with an isolating valve on the inlet pipe and a drain cock unless otherwise stated.

The air valves should be so designed that the balls are prevented from sticking.

Cover plates shall allow free discharge or intake of air, but shall prevent the ingress of foreign matter.

Valves shall be drop tight on shut-off and the design of the valve shall prevent balls from sticking.

When discharging large volumes of air at high rates the ball must not be caught up in the escaping air stream and close before all air has been released.

Tenderers shall submit full particulars of the air valves tendered on with the tender.

M20.6.4 Special Valves

All valves other than sluice and air valves shall be classified as special valves. The general requirements, pressure ratings, protective layers, flanges, markings, tests, etc. as specified in this Section will be applicable to the special valves. The particular valve will be further specified in the Project Specification.

M20.7 GATE VALVES

All gate valves shall comply with the requirements of SABS 664 and shall carry the SABS mark. Gate valves shall completely clear the bore of the valve in the fully open position. The direction of closing shall be clearly marked on the bonnet of the valve. Vales shall be drip-tight from zero to maximum working pressure under test conditions.

M20.7.1 Wedge Gate Valves

Valve seat and gate rings shall be manufactured from bronze to BS 1400 LG2.

Valves except flange faces shall be coated externally and internally with self-etching primer followed by one or more coats of fusion bonded epoxy material to give a total film thickness of at least 250 microns all applied in accordance with the manufacturer's specifications.

Valves where specified shall be supplied with fully enclosed, grease-packed, single-train spur gearboxes with a 3:1 or 4:1 ratio as specified.

Where required bronze gate guides and shoes shall be fitted as additional.

Integral mounted by-pass assemblies shall be fitted as additional where required.

M20.7.1.1 Auxiliary Fittings

Wedge gate valves of 300 mm diameter and larger shall be fitted with the following auxiliary fittings:-

- Drain Plugs

300 mm diameter valves and larger shall be supplied with gunmetal drain-plugs screwed into the lowest point of the valve and the valve body shall be suitably drilled and tapped to accept the drain-plug. The plug must be in position when the test pressure is applied.

- Ball Bearing thrust Collars

  300 mm diameter valves and larger shall be fitted with ball-races on the top and bottom of the thrust collars. The ball-races shall be totally enclosed in a grease-packed cover, which shall be sealed to prevent the egress of grease. Provision must be made for lubricating the ball-races and the lubrication arrangement shall allow for re-greasing while the valve is under pressure.

M20.7.2 Knife Gate Valves

The valve body shall be cast iron with soft rubber lining. Spindle and blade are to be manufactured from stainless steel. Valve seals are to be re-packable and reversible made from Nitrile rubber with PTFE scrapers, to withstand solid particles and grit associated with wastewater and sludge.

Hand wheels shall be rising spindle types. Knife gate valves shall be installed vertically at all times.

M20.7.3 Resilient Seal Valves

Resilient Seal valves ensure tight compression sealing without wear and shall be used as isolating valves. Valve bodies shall have unobstructed, pocket-free, bores i.e. no seating protrusions or gate well, with inclined seats and gate guides to eliminate deposits in the valve body.

The spindle seal shall have at least two Nitrile Butadine rubber to DIN 3770 O-rings located in a corrosion-resistant housing and a wiper ring to prevent ingress of dirt. A back seal shall permit replacement of spindle seats under pressure, with the gate in the fully open position.

The cast iron gate shall be fully covered with a Nitrile Butadine rubber sheath fully bonded to the gate by vulcanising.

Valves shall be smooth bore and shall operate without the use of any wedging action, which may scuff or damage the rubberised gate.

Valves shall be coated with a fusion bonded epoxy coating of minimum thickness 200 microns.

M20.8 NEEDLE VALVES

Type NLV1 needle valves of sizes 50 NB and under shall be used for flow control of dilution water. Needle valves shall be manufactured from stainless steel and shall adhere to ASTMA A 351.

The valve shall be hand operated and the ends of the body shall be screwed to BSP.

M20.9 SPECIAL VALVES

All valves used for special operations and conditions shall be carefully selected.

Tenderers are required to submit full details of the valves offered and the final selection shall be subjected to the approval of the Engineer. The valves offered shall not be accepted as substitutes for the standard valves specified.

M20.10 REFLUX/NON RETURN VALVES

Valves used for sewage effluent or sludge shall be self-cleansing at the base of the gate. The interior shall be smooth and free from any projections.

Valve bodies shall be of cast iron or cast steel depending on the test pressures and the project specification.

Valve doors shall be of cast steel or cast iron. Body rings, door rings and spindles shall be manufactured from stainless steel.

The following types of reflux valves as specified shall be supplied:-

(a) Single sloping swing door for sizes up to 400 mm.
(b) Double sloping swing door for sizes larger than 400 mm and up to 800 mm.
(c) Multiple sloping swing doors for sizes larger than 800 mm.

Valve bodies and seals shall be free of pockets that will allow dirt accumulation.

Valve doors shall be designed to prevent fluttering and shall allow rapid but non-slamming closure on reversal of flow. The gate shall swing free in the body and in fully open position shall not obstruct the flow.

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 springs or external counterweights.

Where specified in the Project Specification, valve doors shall be balanced by attaching counterweights and levers, or hydraulic dampers to the extended valve spindle.

Where valves are fitted to buried pipe lines, only hydraulic dampers shall be used.

M20.11 DIAPHRAGM VALVES

The valve is to be able to handle sludge's, rags and grit as expected in waste treatment works. The valve body must be designed to minimise turbulence and give 100% leak tight closure.

The valve must have a smooth bore and minimise wear from abrasion and allow for rodding when sludge's set in the pipeline.

The valve operating mechanism must be sealed from service and atmosphere.

The diaphragm must be manufactured from tough, resilient type natural rubber of sufficient grade to handle abrasives, acids and alkalis as expected in sewage works.

The valve body is to be cast iron with sufficient corrosion and erosion protection to last the useful life of the valve.

M20.12 BALL VALVES

M20.12.1 Type BLV1

This type is used for general purposes for sizes of 50 NB and under. The ball and stem shall be manufactured from 316 SS and the body shall be 304 SS.

The seat and the gland shall be PTFE material. The valve body shall be of the reduced bore type with ends screwed to BSP. The valve shall be lever operated.

M20.12.2 Type BLV2

BLV2 type ball valves are used for sludge lines. The valve shall be short pattern reduced bore type, fully lined with a Polypropylene or fluorocarbon resin liner.

All interior surfaces including the ball, stem and collar shall be lined to ensure that there is no contact between the metallic components and the lined media. The liners shall be securely retained by means of dovetail grooves within the bore and shall extend over the flange faces.

M20.12.3 Valve Body

The body of the valves shall be manufactured from ductile iron and all external bolts, nuts and gland followers shall be grade 316 material.

M20.13 PRESSURE REDUCING VALVE ANGLE/GLOBE PATTERN TYPE

The pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

M20.13.1 Main Valve

The valve shall be hydraulically operated, pilot-actuated, single or double chamber globe or angle patter. The valve shall consist of three major components: the body, with seat installed; the cover, with bearings installed; and the diaphragm assembly.

The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure form line pressure.

Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

M20.13.2 Main Valve Body

The valve body and cover shall be of cast material. Ductile iron is standard and other materials shall be available. No fabrication or welding shall be used in the manufacturing process.

The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat inset. No O-ring type discs shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edges and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across its surface.

M20.13.2.1 Diaphragm

The diaphragm assembly containing a non-magnetic 304 stainless steel stem with sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover an integral bearing in the valve seat. No centre guides shall be permitted. The stem shall be drilled and tapped in the cover and to receive and affix accessories as may be deemed necessary.

The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from line pressure.

The diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The centre hole for the main valve stem must be sealed by the vulcanised

process or a rubber grommet sealing the centre stem hole from the operating pressure.

The diaphragm must withstand a Mullins Burst Test of a minimum of 4000 kPa per layer of nylon fabric and shall be cycle tested 100 000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

M20.13.2.2 Valve Cover

The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 15 mm and smaller size valves shall be threaded into the cover and body. The valve seat in 200 mm and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits.

To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than the replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted.

M20.13.2.3 Valve Manufacturer

The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three year from date of shipment, provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a one year warranty.

The valve manufacturer shall be able to supply a complete line of equipment from 32 mm through to 600 mm sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a cavitation chart which shall show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity and if there will be cavitation damage.

M20.13.3 Material Specification

Valve Size	:	50-300 mm
Main valve body and cover	:	Cast Iron
Main valve trim	:	Stainless steel
End detail	:	SABS 1123 table 1600/3 or 2500/3 as specified
Pressure rating	:	0-50°
Coating	:	Fusion bonded epoxy

Desired options:-

- X43 "y" strainer or equivalent on pilot piping
- Three ball valves on pilot piping, inlet, outlet and line to cover chamber
- 63 mm diameter pressure gauge, glycerine filled, fitted with 10 mm stainless steel ball valve on Tee-piece on inlet and outlet pilot piping.

M20.13.4 Pilot Control System

The pressure reducing pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting.

The pilot control system shall include a fixed orifice. No variable orifices shall be permitted. The pilot system shall include opening speed control on all valves 100 mm and smaller.

Three-way pilot controls will not be acceptable if the connection of TECHNOLOG “Autowat” or “Ecowat” controllers is specified.

The pilot control shall have a second downstream sensing port which can be utilised to install a pressure gauge.

A full range of spring settings shall be available in the range of 0 to 3000 kPa.

A direct factory representative shall be made available for the start-up service, inspection and necessary adjustments.

M20.13.5 Material Specification for Pilot Control

Pressure rating	:	1600 kPa or 2500 kPa as specified
Trim	:	Stainless Steel
Tubing and Fittings	:	Brass compression fittings with copper tubing
Adjustment range	:	200 to 2000 kPa or 100 to 500 kPa
Operating fluids	:	Water

M20.14 PRESSURE REDUCING VALVE (SINGLE DIAPHRAGM LINER-OPERATED TYPE)

M20.14.1 Function

The pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

M20.14.2 Main Valve

The valve shall be hydraulically operated, pilot activated automatic control valve for pressure reducing service. The valve shall consist of two parts: stainless steel body and an elastomeric liner. The valve shall be positioned in line and be controlled via an external pilot control valve.

M20.14.3 Material Specification

Valve Size		:50-300mm
Main valve Body	:	316 Stainless steel
End Detail (50 to 100 mm)	:	Wafer pattern
End Detail (150 to 300mm)	:	SABS 1123 Table 1600/3 or 2500/3 as specified
Pressure rating	:	1600 kPa or 2500 kPa as specified
Temperature range	:	0 to 70°
Liner Material	:	Natural Rubber

Liner retainer	:	316 Stainless Steel
Coating	:	Fusion bonded epoxy

Desired options:-

- X43 “y” strainer or equivalent on pilot piping
- Three ball valves on pilot piping, inlet, outlet and line to cover chamber
- 63 mm diameter pressure gauge, glycerine filled, fitted with 10 mm stainless steel ball valve on Tee-piece on inlet and outlet pilot piping.

M20.14.4 Pilot Control System

The pressure reducing pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall include a fixed orifice. No variable orifices shall be permitted. The pilot system shall include opening speed control on all valves 100 mm and smaller.

Three-way pilot controls will not be acceptable if the connection of TECHNOLOG “Autowat” or “Ecowat” controllers is specified.

The pilot control shall have a second downstream sensing port which can be utilised to install a pressure gauge.

A full range of spring settings shall be available in the range of 0 to 3000 kPa.

A direct factory representative shall be made available for the start-up service, inspection and necessary adjustments.

M20.14.5 Material Specification for Pilot Control

Pressure rating	:	1600 kPa or 2500 kPa as specified
Trim	:	Stainless Steel
Tubing and Fittings	:	Brass compression fittings with copper tubing
Adjustment range	:	200 to 2000 kPa or 100 to 500 kPa
Operating fluids	:	Water
Desired Options	:	-

M20.15 FLOW LIMITER VALVES

M20.15.1 Screwed type limiter valves

The limiter valve shall consist of a screwed fitting with a rubber control ring orifice insert, which affects a consistent flow control within ± 10 % of the rated flow for a differential pressure across the valves over a range extending from 100 kPa to 1100 kPa.

The body of the limiter valve shall be made of uPVC plastic and shall female screwed at both ends to B.S.P.

The control rings shall be made of flexible nitrile elastomer rubber and must be able to move on a tapered seat in the body as the flow increases and be replaceable. The valve must be complete with control rings for the specified initial flow, which may be replaced in the future

(post-contract) for the final flow settings. The flow settings for the flow limiter valves are indicated in the Project Specification.

The screwed type limiter valve must be stamped with the flow in litres per minute and with an arrow to indicate the direction of flow.

A flow test must be conducted at the suppliers factory or test facilities, on one sample each of 20 mm, 25 mm and 32 mm flow limiter valve as prepared for use in the contract, over the following differential pressures:

Differential Pressure (kPa)	**Tolerance limit on rated flow**
50	± 50%
100	± 10%
150	± 10%
200	± 10%
300	± 101%
1000	± 10%

The measurement of flow rates must be to the satisfaction of the Engineer. If any one of the samples should fail to provide a flow rate within the tolerances specified, then all valves for installation on the contract must be tested for a selection of pressures on the contract must be tested for a selection of pressures up to the static pressures to be expected at installation sites, all to the satisfaction of the Engineer.

M20.15.2 Wafer type limiter valves

The limiter valves shall consist of a wafer pattern with a rubber control ring orifice insert, which affects a consistent flow control within ± 10% of the rated flow for a differential pressure across the valve over a range extending from the 100 kPa to 110 kPa.

The body of the limiter valve shall be made of uPVC plastic.

The control rings shall be made flexible nitrite elastomer rubber and shall be able to move on a tapered seat in body as the flow increases and be replaceable. The valve shall be complete with control rings for the specified initial flow, which may be replaced in the future (post-contract) for the final flow settings. The flow settings for the flow limiter valves are given in the Project Specification.

The limiter valve must be stamped with the flow in litres per minute and with an arrow to indicate the direction of flow.

A flow test must be conducted at the suppliers factory or test facilities, on one sample each of 50 mm and 80 mm flow limiter valve as prepared for use in the contract, over the following differential pressures:-

Differential Pressure (kPa)	**Tolerance limit on rated flow**
50	± 50%
100	± 10%
150	± 10%
200	± 10%
300	± 101%
1000	± 10%

The measurement of flow rates must be to the satisfaction of the Engineer. If any one of the samples should fail to provide a flow rate within the tolerances specified, then all valves for installation on the contract must be tested for a selection of pressures on the contract must be tested for a selection of pressures up to the static pressures to be expected at installation sites, all to the satisfaction of the Engineer.

M20.16 VALVE GEARBOXES

Gearboxes shall not be an integral part of the main body but shall be separate unit mounted to the body for easy removal. All gears shall be machine cut and fully enclosed and the lubrication shall be of the permanent type.

Positive stops shall be provided to prevent over opening or over closing of the units and visual indication of the point of travel at all positions in the open/close cycle shall be provided.

Torque limiting devices shall be fitted to prevent damage to gears and casings due to over tightening. Design of valves and gearboxes shall be such that leakage from the valve along the shaft cannot enter the gearbox.

M20.17 PROTECTION OF VALVES

M20.17.1.1 Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa ½ of SIS 05 59 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP2300 or similar) shall then be applied to give a final dry film thickness of 300 µm. Drying times between successive layers will depend on environmental conditions and will be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solvent-less epoxy paint system or a fusion bonded epoxy powder coating. For fusion-bonded epoxy, a final dry film thickness of 250 µm is required.

Details of the protection required shall be given in the Project Specification.

M20.17.1.2 External Protection

External surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 59 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP2300 or similar) shall then be applied to give a final dry film thickness of 400 µm. Drying times between successive layers will depend on environmental conditions and will be strictly in accordance with the requirements of the paint manufacturer.

Where the specification does not call for an external surface consisting of an epoxy coating, the following shall apply:-

External surfaces of valve bodies shall be wire brushed to a Sa 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer to SANS 679 Type I (dried film thickness 50 µm). This shall be followed by two alkyd-based undercoats (each coat 25 µm thick) and one alkyd-based enamel finishing coat to SANS 630 Grade I (dried film thickness 25 µm). Final colour shall be as specified by the Engineer.

Machined flanges shall be painted with a protective coating of shellac or similar.

Refer to Particular Specification G02: Corrosion Protection

M20.18 TOLERANCES

The tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

M20.19 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

M20.20 TESTING AND INSPECTION

M20.20.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SANS or BS Specification. The Engineer shall not necessarily attend these tests but records must be kept and all test results and tests certificates must be provided to the Engineer.

M20.20.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. The Manufacturer shall provide samples required for such tests free of charge and the independent body in accordance with the relevant SANS or BS Specification shall do sampling.

The cost of such control tests shall be borne by the Employer.

M20.20.3 Inspection

Visual, operational and dimensional inspection of valves as well as inspection of protective coatings shall be carried out by the Engineer and/or the Manufacturer in the Manufacturer's workshop prior to the despatch of valves to site.

The Engineer's inspection will in no way relieve the manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

M20.20.4 Hydrostatic Testing

The Engineer shall witness all hydrostatic tests and the Manufacturer shall give at least one week notification to the Engineer of the proposed dates for such tests.

Valve bodies shall be close ended tested to 2 x working pressure. Test pressures shall be maintained for at least 5 minutes and valve bodies shall be water tight in all respects.

Assembled valves shall be open-ended tested to 1.5 x working pressure for material strength and soundness. Valves shall be drop tight over the complete range of pressures from 0 to 1.5 x working pressure.

Each valve shall be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

M20.21 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.

a world class African city

City of Johannesburg
Johannesburg Water SOC Ltd

17 Harrison Street
Johannesburg

Johannesburg Water
PO Box 61542
Marshalltown
2107

Tel +27(0) 11 688 1400
Fax +27(0) 11 688 1528

www.johannesburgwater.co.za

PARTICULAR SPECIFICATION

M21: MECHANICAL PRESSURE PIPEWORK

4	2013-10-23	Minor updates and re-issued	J Ritchie	
3	2012-07-30	General review	T Wellard	
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

PARTICULAR SPECIFICATION M21: MECHANICAL PRESSURE PIPEWORK

CONTENTS

M21.1 SCOPE 3

M21.2 INTERPRETATIONS 3
M21.2.1 Definitions 3
M21.2.2 Abbreviations 3
M21.2.3 Standards 3
M21.2.4 General Requirements 4

M21.3 CLASS DESIGNATION 4

M21.4 MATERIALS 4
M21.4.1 Standards 4
M21.4.2 Steel (Other than Galvanised) 6

M21.5 UPVC PIPES AND FITTINGS 6
M21.5.1 Handling 6

M21.6 HDPE PIPING 7
M21.6.1 Handling 7

M21.7 MILD STEEL 7

M21.8 CAST IRON PIPES 8

M21.9 STAINLESS STEEL PIPES 8

M21.10 3CR12 PIPES 8

M21.11 DUCTILE IRON PIPES 8

M21.12 STEEL PIPES, SPECIALS AND FITTINGS 9
M21.12.1 General 9
M21.12.2 Materials 9
M21.12.3 Types of Protection 9

M21.13 PIPE CONSTRUCTION 9
M21.13.1 General 9
M21.13.2 Marking of Pipes 9

M21.14 WELDED STEEL PIPES 10
M21.14.1 General 10
M21.14.2 Pipe Ends 11
M21.14.3 Handling 11
M21.14.4 Clamps 11
M21.14.5 Welding 11

M21.15 BONDING OF PIPELINE 11

M21.16 BEDDING AND SUPPORTING OF PIPEWORK 12

M21.17 LAYING OF PIPES 12

M21.18 DAMAGED PIPES 13

M21.19 SIGHT RAILS 13

M21.20 STORAGE OF PIPES AND PREFABRICATED SECTIONS 14

M21.21 JOINTING OF PIPES 14

M21.22 COUPLING DIFFERENT TYPES OF PIPING 15
M21.22.1 Making of Openings 15
M21.22.2 Positioning of Valves and Fittings 15
M21.22.3 Thrust Blocks 16

M21.23 CUT PIPES AND PREFABRICATED SECTIONS 17
M21.23.1 Sterilizing of Pipelines 18
M21.23.2 Route Markers 18
M21.23.3 Protective Layers on Pipes and Fittings 18
M21.23.4 Flexible and Flanged Couplings 19

M21.24 COLOUR CODES 19

M21.25 TOLERANCES 19

M21.26 TESTING 20
M21.26.1 Steel Pipes and Pipe Fittings 20
M21.26.2 Non-Destructive Tests 20
M21.26.3 Destructive Tests 21
M21.26.4 Testing and Inspection on Site 21
M21.26.5 Other Pipe Materials 23

M21.27 MEASUREMENT AND PAYMENT 23

M21.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of pipework, pipe items, protective coatings and describes methods for laying and jointing of pipes. The Particular Specification shall be read in conjunction with the Project Specification.

M21.2 INTERPRETATIONS

M21.2.1 Definitions

For the purposes of this Specification the following definitions shall apply:-

(a) Cut Lengths

Where this term is used in the Specifications, on the Drawings or in the Schedule of Quantities it shall be taken to mean a pipe of differing length from the standard length for pipes as supplied by the manufacturer.

Cut lengths are required as closure pieces between standard pipe lengths, between the ends of a pipe fitting or between pipe fittings.

(b) Plain End

This term refers to a pipe end that has been cut, machined or finished in a manner suitable for coupling to a pipe with a similar end as specified.

M21.2.2 Abbreviations

For the purpose of this Specification the following abbreviation shall apply:-

ASTM	:	American Society for Testing and Materials
API	:	American Petroleum Institute
BS	:	British Standard
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
uPVC	:	Unplasticised Polyvinyl Chloride
ISO	:	International Standards Organsiation
DIN	:	Deutsches Institut für Normung
HDPE	:	High Density Polyethylene
MPVC	:	Modified Polyvinyl Chloride Pipes

M21.2.3 Standards

All design standards for the pressure pipework shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10400	:	National Building Regulations
SANS 9096-1: 1994	:	Testing of welders, where applicable to the type of welding required
SANS 10064	:	The preparation of steel surfaces for coating
SANS 10102-4	:	Selection of pipes for buried pipelines Part 1: General Provisions
SANS 10111-2-1	:	Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section

8: Corrosion resistant stainless steel fasteners-Nuts

SANS 455 : Covered electrodes for the manual arc welding of carbon and carbon manganese steels

DWS 1110 : Construction of pipelines

M21.2.4 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M21.3 CLASS DESIGNATION

Pipe classes indicated on Drawings and in the Specification should have the following meaning:-

Working Pressure (kPa)	Steel Pipes
300	
600	6
900	
1 000	10
1 200	
1 500	
1 600	16
1 800	
2 100	
2 400	
2 500	25

M21.4 MATERIALS

The type, ability and condition of the equipment and material are subject to the Engineer's approval.

Covered electrodes of mild steel or medium high tensile steel for hand welding must comply with SANS 455 and carry the SANS mark.

The Contractor must submit full particulars off all electrodes he intends using to the Engineer. All electrodes must be supplied by the Contractor and the consignment number submitted to the Engineer. Should a different consignment be used on the works, the Engineer may alter the welding procedure.

M21.4.1 Standards

M21.4.1.1 uPVC Pipes

Requirements:-

SANS 966 : uPVC Type I Pressure Pipes and Fittings for Cold Water Services
SANS 967 : Unplasticised poly(vinyl chloride) (PVC-U) soil, waste and vent pipes and pipe fittings
ISO 4422 : Pipes and fittings made of unplasticised poly (vinyl chloride) (PVC-U) for water supply – Specifications
SANS 1123 : Pipe flanges
SANS 791 : unplasticised poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings
SANS ISO 4427 : Components of Unplasticised Polyvinyl Chloride (uPVC) Pressure

Pipe Systems for potable water

SABS 0112	:	The installation of polyethylene and unplasticised polyvinyl chloride pipes
BS 3505	:	Unplasticised polyvinyl chloride pressure pipes for cold potable water
DIN 8061	:	A1:1991 Unplasticised polyvinyl chloride pipes: General quality requirements and testing
ISO 1167	:	Plastic pipes for the transport of fluids: determination of the resistance to internal pressure.
ISO 1628	:	Plastics determination of viscosity number and limiting viscosity number. Part 2: PVC resins.
ISO 4422	:	Pipes and fittings made of unplasticised polyvinyl chloride for water supply specifications

125 & 140mm sizes are not recommended for uPVC pipes due to the lack of standard fitting.

M21.4.1.2 HDPE

Requirements:-

SANS ISO 4427	:	Black polyethylene pipes for the conveyance of liquids

M21.4.1.3 Mild Steel

Requirements:-

SANS 719 grade B	:	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 62	:	Steel pipe and pipe fittings up to 150 mm nominal bore

M21.4.1.4 Cast Iron

Requirements:-

BS 2035	:	Cast Iron flanged pipes and flanged fittings.
SANS 509	:	Malleable cast iron pipe fittings.
SANS 664	:	Cast Iron gate valves.
SANS 746	:	Cast-iron pipes and pipe fittings for use above ground in drainage installations

M21.4.1.5 Stainless Steel

Requirements:-

SANS 1044-3	:	Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 1044-4	:	Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.
SANS 10162-4	:	Structural use of Steel Part 4: The design of cold-formed stainless steel structural

M21.4.1.6 Ductile Iron

Requirements:-

SANS 1835	:	Ductile iron pipes, fittings, accessories and their joints, for use in high and low pressure systems for potable and foul water
SANS 50545	:	Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods
SANS 50598:1994	:	Ductile iron pipes, fittings, accessories and their joints for sewerage application - Requirements and test methods

M21.4.2 Steel (Other than Galvanised)

M21.4.2.1 Manufacturing Specifications

SANS 62	:	Steel pipe and pipe fittings up to 150 mm nominal bore
SANS 719	:	Electric welded low carbon steel pipes for aqueous fluids
SANS 1123	:	Standard Specification for steel pipe flanges
BS 4504	:	Flanges and bolting for pipes, valves and fittings

M21.4.2.2 Welding Specifications

BS 1965	:	Butt-welding pipe fittings.
BS 2633	:	Metal-arc welding of steel pipe lines and pipe assemblies for carrying fluids.
BS 4504	:	Flanges and bolting for pipes, valves and fittings.
API 5L	:	Specification for line pipe.
API 5LS	:	Specification for spiral-weld line pipe.
API 1104	:	Standard for welding pipe lines and related facilities.

M21.4.2.3 Protective Coatings

SANS 763	:	Hot-dipped (galvanised) zinc coatings.
SANS 0129	:	Code of Practise for plastic tape wrapping of steel pipe lines.
SANS 1117	:	Plastic wrapping for the protection of steel pipe lines.
SANS 1130	:	Glass fibre reinforcing material for pipe wrapping.
SANS 1136	:	Cold applied bitumen primer for steel pipe line protection.
SANS 1137	:	Hot applied bitumen for steel pipe line protection.
SANS 1138	:	Cold applied coal tar primer for steel pipe line protection.
SANS 1139	:	Hot applied coal tar enamel for steel pipe line protection.
SANS 1178	:	The production of lined and coated steel pipes using bitumen or coal tar enamel.
SIS 05 59 00	:	Pictorial surface preparation standards for painting steel surfaces.

M21.5 UPVC PIPES AND FITTINGS

All manufacturers of uPVC and MPVC pipes, fittings and couplings must be quality listed by the South African Bureau of Standards to comply with SABS ISO 9002.

All exposed uPVC piping shall be protected against ultra-violet degradation by the application of two coats of white PVA paint after degreasing.

Where flanged ends are required, the end of the pipe shall be prepared with a solvent welded stub adaptor to accommodate a galvanised steel backing flange.

All sludge and polyelectrolyte pipework shall be uPVC and rated 9 bar pressure and shall adequately supported to prevent sagging.

M21.5.1 Handling

Care shall be taken when handling uPVC pipes to ensure that pipes are not dropped or mishandled. Piping in transit shall be adequately secured using straps to prevent abrasion and surface damage.

During transport, handling and storage, the Contractor shall ensure that the pipes lie on a smooth surface and are not in contact with sharp objects and are not subjected to point or linear loads.

Yield (MPa) at 28° C	Tensile Modulus (GPa) 23°C	Max Temperature	Design Stress (MPa) at 20°C	Minimum Safety factor at 50 years

55	2.7-3.0	60	10,000	2.1

M21.6 HDPE PIPING

Flange couplings shall be kept to a minimum. Where the standard length of pipe is less than the required length, butt weld or flanged connections shall be used.

HDPE stub ends and loose flange connections may be butt welded and the bead formed inside the pipe shall be removed to avoid restrictions and product build-up. All flanges and bolts shall be galvanised.

Pipe work shall be adequately supported depending upon the size and class to prevent pipe sag. Where pipework is exposed directly to the environment, provision shall be made for suitable horizontal expansion joints.

M21.6.1 Handling

Care shall be taken when handling HDPE pipes to ensure that pipes are not dropped or mishandled. Piping in transit shall be adequately secured using straps to prevent abrasion and surface damage.

During transport, handling and storage, the Contractor shall ensure that the pipes lie on a smooth surface and are not in contact with sharp objects and are not subjected to point or linear loads.

The maximum stacking height for class 6-10 pipes shall not exceed 2m. All pipes exhibiting damage shall be rejected.

Yield (MPa) at 28° C	Tensile Modulus (GPa) 23°C	Max Temperature	Design Stress (MPa) at 20°C	Minimum Safety factor at 50 years
20	0.7-0.95	80	5,0	1.3

M21.7 MILD STEEL

All mild steel pipework and fittings other than steam tubing and screwed and socketed pipe, larger than 150 mm diameter shall comply with the requirements of SABS 719 grade B and shall have a minimum wall thickness as follows:

Normal Bore mm	**Min Wall Thickness mm**
Less than 400 mm	4
400-500	5
600-700	6
750-900	8
950-1100	10
1100-1500	12
1600-1800	14

Pipework other than screwed and socketed of sizes up to and including 150 mm nominal bore, shall comply with the requirements of SABS 62. These pipes shall be heavy class with flanged joints and suitable for a minimum working pressure of 1.6 MPa.

All screwed and socketed pipes shall comply with the requirements of SABS 62 Medium class and shall be “hot dip” galvanised. Unless otherwise specified screwed and socketed pipes shall not be used for the conveyance of steam, gas and compressed air. Compressed air pipelines of diameter 25 mm or less may be screwed and socketed.

Plain ends of pipes and fittings shall be protected against damage while being transported from the factory to the site. Details of the proposed protection system shall be submitted by the Engineer for approval.

M21.8 CAST IRON PIPES

All cast iron fittings shall be factory coated internally and externally with one coat bitumen paint to BS 3416 Type II leaving a dried film thickness of not less than 25 µm.

(a) All Exposed pipes and fittings except pipes installed in potable water retaining structures. Method of corrosion protection shall be specified in the project specification.

(b) After installation paint with one further coat as per factory coat.

M21.9 STAINLESS STEEL PIPES

Stainless steel shall be ANSI Type 304L or 316L as stated in the detailed specification. Where no welding is required Type 304 or 316 may be used. Manufacturers test certificates shall be provided for each material and each stainless steel item supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

Welding of stainless steel shall be carried out using welding electrodes most suitable for the material and its applications by reference to the manufacturer's recommendations. Special precautions shall be taken to ensure that the strength and corrosion resistance of the material is not impaired by prolonged heating of the welds. All welds and adjacent areas shall be cleaned and pickled to remove the area of discolouration with a nitric and hydrofluoric acid formulation as recommended by the material suppliers.

After cleaning pickling all areas shall be thoroughly washed with clean water and re-passivated thereafter with a proprietary passivating solution of 10 per cent – 20 per cent nitric acid in aqueous solution recommended by the material suppliers.

M21.10 3CR12 PIPES

Test certificates and marking shall be used for 3CR12 as per stainless steel.

All 3CR12 shall be supplied "passivated" and upon completion of fabrication welds and other areas where the passivating layer has been removed or damaged and are contamination with mild steel or discoloured shall be cleaned and pickled using nitric acid and hydrofluoric acid formulation as recommended by the material suppliers. After cleaning/pickling all areas shall be thoroughly washed with a proprietary passivating solution of 10 per cent – 20 per cent nitric acid in aqueous solution recommended by the material suppliers.

Welding of 3CR12 steel shall be carried out under controlled conditions using stainless steel 309L welding rod or similar approved and recommended by the material suppliers. All welds shall be continuous and crevice free.

Where a fabricator has shops that deal with both carbon steel and stainless/ 3CR12 fabrications these shops are to be totally separated and no grinding wheels, etc., shall be interchanged between shops.

M21.11 DUCTILE IRON PIPES

Ductile iron pipes and fittings shall comply with ISO 2531. The nominal diameters of ductile iron are 80 to 2000mm.

The pressure rating of ductile iron is K9 range, with the nominal pressure of 3200 kPa. A safety factor of 4 times the working pressure shall be used for ductile iron pipes.

An integral rubber ring socket and spigot is used for the jointing. Ductile iron pipes shall have a inner lining of alumina cement mortar.

M21.12 STEEL PIPES, SPECIALS AND FITTINGS

M21.12.1 General

Protective coatings shall be either "factory" implying coating prior to delivery from the factory to Site, or "Site" implying coating on the Site after the item has been installed.

Undercoats shall be coloured differently to ensure complete coverage with each coat.

External protections other than specified in this clause e.g. coal, tar, enamel and proprietary types of tape wrapping shall when called for in the Schedule of Quantities be carried out as specified.

M21.12.2 Materials

Materials used for spun bitumen lining and bitumen fibre glass wrapping of pipes and the method to be followed shall comply with SANS 720.

Epoxy resin paint shall be approved by the Engineer and shall not break down chemically with time or affect the potability or cause discolouration of potable water in any way and the primer used with such paints shall be zinc rich epoxy type compatible with the paint. Bitumen based aluminium paint to be to SANS 802.

Undercoat for alkyd based enamel paint to be to SANS 681 Type II, and colour to match final decorative paint. Alkyd based enamel paint to be to SANS 630 Grade I.

Zinc chromate primer to be to SANS 679 Type I.

Bitumen paint to BS 3416 (Type II where specified).

M21.12.3 Types of Protection

Pipe work and fittings will be protected in accordance with the Particular Specification G02: Corrosion Protection.

M21.13 PIPE CONSTRUCTION

M21.13.1 General

Pipes shall be tested hydraulically in accordance with SABS 719 and test certificates shall be submitted to the Engineer before the pipes leave the manufacturers workshops.

M21.13.2 Marking of Pipes

The following markings shall be legibly and indelibly marked on each pipe and coupling:-

(a) The name, trade name or registered trade mark of the manufacturer.

(b) The nominal internal diameter.

(c) The class of pipe and colour code (marked at each end).

(d) The wall thickness (for steel pipes).

(e) Length of pipe (if different from the standard length)

(f) Pipe items, specials and valves shall be legibly and indelibly marked with the item number corresponding to the item number given in the Item Lists on the Drawings, or where Item Lists are not provided, the item number in the Schedule of Quantities.

M21.13.2.1 Information to be Supplied:-

The following information shall be made available to the Engineer prior to the award of the Contract:-

(a) Make and types of pipe offered.

(b) The friction loss formula applicable to the types of pipe offered.

(c) Standard pipe length.

(d) Thickness of pipe wall.

(e) Type of coupling and degree of maximum safe deflection permissible with the coupling.

Where the Contract calls for the supply, delivery and laying of the piping, the unit rate tendered for straight pipes shall include for one complete coupling (i.e. including rubber rings, insertion, bolts, etc.) per pipe length and shall include for the protection of the coupling.

Where the Contract calls for the supply and delivery only of the piping, the unit rate tendered for straight pipes shall include for one complete coupling per pipe length together with sufficient material for protecting the coupling.

Where the Contract calls for taking delivery of and laying the piping the unit rate tendered for straight pipes shall include for the labour necessary for protecting the couplings.

M21.14 WELDED STEEL PIPES

M21.14.1 General

Welders must be successfully tested in accordance with SANS 044 Part V by a certificate institution defined by SANS 044 Part V. The Contractor is responsible for the competency certificates of the welders. The Contractor must issue each welder with such equipment so that a welder can identify his joints. A list of identification marks must be kept by the Contractor and made available to the Engineer.

Should two joints of a particular welder not withstand the prescribed test, the welder may not undertake any more welds.

Pipes shall be manufactured by an approved welding process and shall not incorporate more than one longitudinal seam for pipes up to and including 1 000 mm diameter or two longitudinal seams for pipes bigger than 1 000 mm diameter.

Pipe specials shall be manufactured strictly as shown on the Drawings and described in the Documents. Plate thickness shall be such to ensure that the maximum stress shall not be higher than for an uncut pipe in the same pipeline.

The maximum angle between butt-ends of segments for gusseted bends shall be 22½E.

M21.14.2 Pipe Ends

Pipe ends must be thoroughly cleaned of all rust, grease and protection which may affect the quality of the weld. For cut lengths the ends must be bevelled to 30E with the end of the pipe and the roof surface prepared all at the Contractor's own cost. Should laminating, splitting of ends or any other defect occur during welding, the Contractor must cut the defective areas from the pipe.

M21.14.3 Handling

Pipes shall be brought in position in such a manner that damage to the pipes is avoided. Should the pipes have a longitudinal joint, the pipes must be placed so that this joint lies in the top third of the completed line. These longitudinal joints must be staggered at 20E from each other.

M21.14.4 Clamps

Internal clamps must be used to keep the pipes in position during the welding. The root opening must be between 1,5 and 3,0 mm and the pipes may not deviate more than 1,5 mm from the concentric.

Clamps may be removed only after 50 % of the root weld has been completed in equal sections around the perimeter of the pipes.

M21.14.5 Welding

Root welding may at no place be thicker than two thirds of the pipe wall and must be without defects.

Welding must be thoroughly cleared of slag, scale and oxide before the next weld is applied. Weld joints must consist of at least two welds to ensure the specified reinforcing.

Complete penetration must be ensured by letting the weld reinforcement protrude 1,5 mm on the inside of the pipe. No other protrusions will be allowed on the inside of the pipe.

Weld joints must be built up until the weld reinforcement protrudes between 0,8 mm to 1,6 mm above the pipe. The cover weld must be 3,2 mm wider than the original groove width.

In order to avoid cracks, the second or "warm" weld must be applied immediately after the root weld has been cleaned and prior to the cooling of the pipe at the joint.

The internal weld bead on welded seams shall protrude a maximum of 1,0 mm into the barrel of the pipe. For butt-welded pipelines the weld bead shall be ground flush with the pipe body at each pipe end.

The Contractor must submit with his tender a Qualification of Welding Procedures as set out in Section 2 of API Std 1104 including a procedure specification as set out in paragraphs 2.3a, d, e, f, g, h, I, j, k, l, m, n, p, q and r of above specification. The Contractor must demonstrate that this proposed procedure will produce an acceptable pipeline. Should tests reveal that an acceptable result cannot be obtained; the Contractor shall alter his procedure and qualification so that the desired result is obtained.

No welding may take place should inclement weather including rain, sand and wind result in bad joints. If practical, shelters may be erected. The Engineer's representative will decide if the weather is suitable for welding or not.

M21.15 BONDING OF PIPELINE

It may be necessary as a result of tests to be carried out by the Employer, for the pipeline to be

bonded across couplings for electrical continuity.

The bonds shall consist of lengths of 16 mm² PVC sheathed cable secured to the pipeline by thermal welding. Each and every flexible and flanged coupling will be bonded across except in the case of valve chambers where the bonding will take place in the form of a bypass around the outside of the chamber. At flexible couplings two fastenings to the pipe (one on either side of the coupling) and one to the barrel of the coupling shall be made. The external protection of the pipe shall be made good by filling the space cleared of wrapping for the connection with bitumen as used for wrapping the pipe, such that the depth of bitumen thus applied is equal to the depth of the wrapping.

The bonding shall be carried out as soon as possible after installation of the piping and before joints are protected and backfilled. The cables shall be installed in accordance with the requirements of the supplier and to the satisfaction of the Engineer.

Bonding of pipes shall be measured per joint unit. This price shall include for supplying of materials, transporting on Site and installing bonds and making good of pipe wrapping all as described in this Clause.

M21.16 BEDDING AND SUPPORTING OF PIPEWORK

In all cases buried pipes shall be laid on a 50 mm thick bedding layer, surrounded and covered to a height 150 mm above the pipe with selected fill material complying with the requirements of standardized specification unless otherwise indicated on the Drawings or ordered by the Engineer.

Bedding material shall be to the same Specification as selected fill.

Exposed pipework shall be adequately supported on concrete pads and fastened down with approved metal straps with rag-bolts cast into the concrete or with holder bats or as indicated on the Drawings or directed by the Engineer.

M21.17 LAYING OF PIPES

Only qualified workmen shall be employed for the laying and jointing of pipes and proper tools shall be used for the execution of the works. Care shall be taken during construction that the ends of pipes are not hit against each other and pipe ends are damaged in this way.

Once a sufficient length of trench has been excavated and trimmed to the required levels and grades, the pipes shall be lifted and carefully lowered into the trench and placed on the prepared bedding layer (where gravel bedding layers are called for).

Immediately prior to laying the pipe or fitting, it shall be carefully examined both externally and internally for any damage or defect, and all foreign matter shall be removed from inside of the pipe.

Pipes shall be laid evenly on the prepared bedding layer that shall be free of hollows, bumps or other irregularities. Where any such irregularities occurring in this layer prevent the pipe barrel from bearing on the bedding layer for its full length between joint holes, the pipe shall be lifted out of the trench or moved to one side while the bedding layer is trimmed in the specified manner, and where such filling or trimming is necessary as a result of any fault or omission on the part of the Contractor responsible for excavating the trenches, the additional handling of the pipe and trimming shall be to his own cost.

A guideline shall be strung parallel to the centre-line of the pipe and at the height of the centre-line of the pipe. Alternatively the Contractor may make use of a laser beam grade indicator.

All pipes and fittings shall be laid to the true lines and levels indicated on the drawings or as instructed by the Engineer. Pipes and fittings shall be positioned concentrically correct so as to obtain a thoroughly uniform joint. Where possible pipes shall be laid by commencing at the lower end of the grade and working uphill, and in the case of spigot and socket pipes, the socket end of the pipe shall face uphill.

In order to prevent foreign matter entering pipes already laid, a properly fitting wooden or other approved type plug or cap shall be used to cover the end of the last pipe laid whenever laying of pipes is interrupted.

Under no circumstances will the Contractor be permitted to use stones, corrugated iron or cement bags to cover the open end of closed pipes.

An approved pipe "cleaner" attached to a sturdy rope and left in the mouth of the pipe already laid and jointed, shall be pulled forward through the pipeline as each successive pipe is laid. The scraper and ropes used must be of soft material, which will not damage the inner surface of the pipes.

M21.18 DAMAGED PIPES

Damaged or defective pipes or fittings may not be used but shall be placed to one side for inspection by the Engineer who will determine and decide whether the damage is of such a nature that the pipe or fitting shall be rejected or whether it is so slight that it may be repaired on the Site. The decision of the Engineer with regard to the rejection of the damaged or defective pipes and fittings shall be final. Pipes and fittings shall be replaced or repairs undertaken by the Contractor at his own cost to the full satisfaction of the Engineer. In the case of pipes and fittings provided by the Employer, the responsibility of the Contractor for the repair and replacement of damaged pipes and fittings will commence once the Contractor has taken delivery of the material from the Employer. Before taking over any material from the Employer, he shall thoroughly inspect all material and immediately report any damage or defects therein to the Engineer.

The Engineer shall have the right to order the removal of any defective or damaged pipe or fitting that has not been repaired or approved as described above, from the pipe line, irrespective of whether such pipe or fitting has been laid and joined in the pipe line or not, and the Contractor must then undertake the removal and replacement of such pipe or fitting to the complete satisfaction of the Engineer, at his own cost.

M21.19 SIGHT RAILS

In all cases pipes are to be laid to definite lines and levels and sight rails shall be erected after setting out, at changes in direction and grade and at intermediate positions such that the distance between sight rails does not exceed 50 m or as the Engineer may require.

Sight rails for bulk excavation of trenches may be temporary to suit the Contractor's requirements but for purpose of final trimming and pipe laying sight rails shall be of sturdy construction, firmly planted and have the cross-arm neatly and clearly painted black and white.

Boning rods shall be well constructed with the cross-arm painted red or other colour contrasting with the sight rail. Sight rails and boning rods shall be maintained in a clean and sound condition and shall be subject to the approval of the Engineer at all times.

M21.20 STORAGE OF PIPES AND PREFABRICATED SECTIONS

Unless specifically stated to the contrary, the Contractor shall supply, deliver and install, as shown on the Drawings and in the Schedule of Quantities, all pipes, prefabricated sections and accessories required under each particular Section of the various Sections of the Contract.

Unless the pipes, prefabricated sections and accessories are off-loaded on the side of the excavated trench, the Contractor shall stack such pipes, prefabricated sections and accessories on an approved site. The cost involved in the transport from such storage place to the section of the trench where the drain or pipe line has to be built, shall be included in the construction cost.

During transport, handling, stacking and placing, the prefabricated units shall be protected against damage.

The Engineer reserves the right to restrict the height to which pipes may be stacked. Pipes larger than 300 mm diameter may not be stacked at all.

M21.21 JOINTING OF PIPES

Only suitably qualified workmen will be permitted to lay and join pipes and suitable equipment must be used for the execution of work.

Before they are joined together, the ends of pipes and all fittings and flanges shall be inspected and cleaned.

(a) Flanged Joints

Where flanged pipework, valves, etc., are to be connected, the insertion material shall be cut to the correct size and provided with bolt holes. The insertion material shall be positioned immediately prior to the two flanges being brought together and the whole joint must then be bolted together by tightening diametrically opposite bolts in sequence.

(b) Flexible Joints (Viking Johnson Type)

The flanges must be placed in position first; one over each end of the pipe, and the rubber rings must then be inserted by pulling them over the ends of the pipes or by using special pointed plugs, the point of which has been placed in the end of the pipe. Any twists in the rubber rings must be removed by rolling the rings along the outside of the pipe and they must then be brought into position so that the distance from the end of the pipe to the ring is equal to half the length of the detachable collar. The collar shall be placed over the end of one of the pipes and the two pipe ends shall be brought together in such a way that the collar is placed centrally over the joint. The bolts must then be placed through the flanges and carefully and evenly tightened to the required torque, thus ensuring a watertight joint.

(c) Flexible Joints (Loose Collar Type)

The pipe barrel shall be thoroughly cleaned over the area to be covered by the coupling. The coupling shall be installed strictly in accordance with the manufacturer's instructions - a copy of which shall be kept by the Contractor on Site.

(d) Screwed Joints

Screw threads on pipes and in sockets shall conform to the relevant standards. Threading on Site will be subject to the approval of the Engineer. PTFE tape only shall

be used for thread sealing. Sockets shall not be over tightened and the pipes shall be screwed the same distance into the socket on either side.

(e) Spigot and Socket Joints

For spigot and socket joints the ring shall be placed around the spigot end of the pipe, perpendicular to the centre-line and as near as possible to the end. The ring shall be clean, dry and not twisted. The joint is made by pushing the pivot in the socket by means of a crowbar or block and tackle. If the pipe is inclined to creep out of the joint, it is a sign that the ring is not rolled on evenly and it must be redone.

(f) Open Joints

For open joints the pipes shall be laid close together and any gap larger than 3 mm on the inside as well as outside shall be filled completely with 3:1 cement mortar and on the outside covered with one layer of jute material soaked in the same mortar. The jute material must overlap the joint by at least 75 mm on both sides.

M21.22 COUPLING DIFFERENT TYPES OF PIPING

The following methods shall be used for connecting different types of pipe together:-

Cast iron flange adaptors or steel flange and spigot pieces to suit the types of piping shall be coupled with a flexible coupling on one end and bolted to a flange on the other end which may, in the case of steel piping, be welded or screwed on.

Where a steel pipe is to be connected to an asbestos cement pipe with a larger outside diameter, without the use of a flange adaptor to the end of steel pipe shall be furnished with a steel ring welded on or, in the case of galvanised piping, a special galvanised steel socket shall be screwed on such that the outside diameters of the pipes match and the pipes may then be joined with a flexible coupling.

M21.22.1 Making of Openings

Where drains have to be joined to existing structures or existing drains or newly constructed prefabricated box culverts in such a way that it was not possible for the Contractor to leave openings for the joining or building in of prefabricated units, such openings shall be made according to the instructions of the Engineer.

The Contractor shall supply the necessary equipment and labour to make the openings according to the dimensions and/or requirements directed by the Engineer without damaging the rest of the structure or drain. If the openings are made too large or the rest of the structures or drain is damaged in any way, the Contractor shall repair it at his own expense to the satisfaction of the Engineer.

Blasting to make openings will only be permitted in exceptional circumstances.

Where necessary, parts of the existing structure or drain shall be propped until the junction of the new drain is completed.

The prefabricated units must be built into the openings or the other drains joined thereto as directed by the Engineer and the joint shall be finished neatly so that a minimum of obstruction is caused to the flow of water. The Contractor must provide all material, tools and labour to make the new junction.

M21.22.2 Positioning of Valves and Fittings

All valves and fittings shall be correctly positioned as indicated on the Drawings, and where necessary shall be supported by concrete pads. Spindle guides and anchors shall be fixed to the brickwork or concrete and carefully adjusted to ensure correct operation of the spindle.

M21.22.3 Thrust Blocks

Unless otherwise ordered by the Engineer, concrete Class 25/19 MPa thrust blocks shall be cast as a support for bends, tees and caps and at valves. The size of the thrust will depend on the strength of the soil, the pipe diameter, the working pressure and the type of item to be supported.

All thrust blocks shall be cast against undisturbed soil and in such a manner as to leave all couplings accessible and such that the bearing area is in accordance with the table given below, which table is based on the assumption that the safe bearing capacity of the soil is at least 100 kN/m². The Engineer will determine in each case the safe bearing capacity for the soil, and the bearing area of the thrust block may then be interpolated from the table. The areas are given in square metres.

Thrust blocks and pipework supports inside buildings shall be constructed to the dimensions given on the Drawings or as directed by the Engineer after the piping and fittings are installed in position.

Note: Bearing area of thrust blocks for pipe diameters, working pressures and bends not stated in the table below, shall be interpolated from the values given.

Nominal Pipe Diameter (mm)	Working Pressure KPa	Bends				End Caps and T-pieces
		11.25º	22.50º	45.00º	90.00º	
100	300	0.010	0.020	0.035	0.065	0.045
	900	0.025	0.050	0.100	0.185	0.130
	1 500	0.045	0.085	0.165	0.305	0.215
	2 100	0.060	0.120	0.230	0.425	0.300
200	300	0.035	0.070	0.135	0.245	0.175
	900	0.107	0.200	0.395	0.725	0.515
	1 500	0.170	0.335	0.655	1.210	0.855
	2 100	0.235	0.470	0.915	1.695	1.195
300	300	0.080	0.150	0.295	0.545	0.385
	900	0.230	0.450	0.885	1.630	1.150
	1 500	0.380	0.750	1.475	2.720	1.920
	2 100	0.530	1.050	2.060	3.805	2.685
400	300	0.135	0.265	0.515	0.950	0.670
	900	0.395	0.785	1.540	2.845	2.005
	1 500	0.660	1.310	2.565	4.740	3.340
	2 100	0.920	1.895	3.590	6.635	4.675
500	300	0.210	0.420	0.820	1.510	1.065
	900	0.630	1.250	2.455	4.530	3.195
	1 500	1.050	2.085	4.085	7.550	5.325
	2 100	1.465	2.915	5.720	10.565	7.450
600	300	0.305	0.600	1.180	2.175	1.535
	900	0.905	1.800	3.530	6.521	4.600
	1 500	1.510	3.000	5.885	10.870	7.665
	2 100	2.110	4.200	8.235	15.215	10.730
800	300	0.540	1.070	2.095	3.865	2.725

Nominal Pipe Diameter (mm)	Working Pressure KPa	Bends				End Caps and T-pieces
		11.25º	22.50º	45.00º	90.00º	
	900	1.610	3.200	6.275	11.595	8.175
	1 500	2.680	5.335	10.460	19.320	13.625
	2 100	3.750	7.465	14.640	27.050	19.070
1 000	300	0.840	1.670	3.270	6.040	4.260
	900	2.510	5.000	9.805	18.110	12.770
	1 500	4.185	8.050	16.340	30.185	21.285
	2 100	5.855	11.660	22.875	42.260	29.795

M21.23 CUT PIPES AND PREFABRICATED SECTIONS

Cut pipes may only be used with the Engineer's permission and the ends shall be cut square to the length of the pipe and finished smooth and evenly so that the cut ends is not inferior to that of an uncut pipe.

The Contractor shall measure the length required for a cut length, cut the pipe, prepare the end for the required coupling and install the cut length. The cutting and end-finishing operations shall be done with special tools available for the particular type of piping such that the cut end is not inferior to the factory made end. In the case of asbestos cement piping particularly, an end cutting machine as supplied by the pipe manufacturers only, shall be used for cutting and preparing the end.

In the case of steel pipes since the ends only are truly circular, it is necessary that cut lengths be factory made and prepared. The prices tendered for cut lengths for various types, classes and diameters of piping shall include for the cutting and end finishing operations but exclude the actual pipe length used as this will be measured and paid for under the item provided for supplying and/or laying of straight pipes. The price shall however, include for one coupling as required, and for any possible wastage.

In the case of sewer pipes, cut pipes may only be used at manholes and the cut end shall wherever possible be built into the manhole. Prefabricated units may only be trimmed or cut where they join structures or other drains.

Box culvert sections may only be trimmed or cut perpendicular to the direction of flow to obtain the correct length and units of the correct skew shall be obtained from the manufacturer where the box culvert drain joins at a skew and in such cases the second last unit shall be trimmed or cut to obtain the correct length.

The ends of pipes to be built in shall be trimmed or cut to the correct skew to be finished smoothly on the inside face of the wall into which it is built.

Units shall be cut in such a way that the edges are not shattered or cracks are not caused in the concrete where the structural strength of the unit causes it to break. When it is trimmed it shall be cut or sawn to obtain the correct length and skew end.

The necessary openings for junctions shall be left when structures or drains are constructed. If the Contractor neglects to leave such openings, he shall, at his own expense, make such openings afterwards or remove the building work and reconstruct it with openings, all according to the Engineer's directions.

Units must fit neatly into the openings provided for them and must be firmly concreted or built in without any obstruction to the flow of water.

M21.23.1 Sterilizing of Pipelines

Pipelines that are to be used for potable water shall be sterilized over its complete length before it is taken into use.

The pipe shall be filled with potable water chlorinated to a concentration of 10 mg of chlorine per litre of water which shall remain with the inner surface of the pipe line for a period of not less than 24 hours. The pipeline is to be filled for sterilizing in such a manner that no shock is created or air trapped in the pipeline.

The Contractor shall at least 14 days prior to the commencement of sterilizing, submit full details of the proposed method of sterilizing the pipe line to the Engineer for his approval.

The Contractor shall provide all necessary tools, equipment and labour necessary to sterilize the pipeline. After sterilizing the pipe line the Contractor shall, at no extra cost empty the pipe lines and dispose of the water in a manner approved by the Engineer.

The Contractor may use the following products as a source of chlorine:-

(a) Chloride of Lime to SANS 295 yielding one third by weight free chlorine.

(b) Calcium Hyper Chloride to SANS 295 yielding 70% by weight free chlorine.

(c) Chlorine gas applied by chlorinator.

The unit rates tendered under the items in the Schedule of Quantities for sterilizing pipe lines shall include for all materials (including water) and labour necessary and shall also include for all arrangements the Contractor may have to make in order to obtain water and fill the pipe line.

M21.23.2 Route Markers

In certain instances concrete pipe route markers may be required. Such markers shall be detailed fully in the Project Specification.

M21.23.3 Protective Layers on Pipes and Fittings

Unless otherwise indicated on the Drawings or stated in the Schedule of Quantities, pipes, specials and fittings shall be protected as shown here-under. Note that preparation of metal surfaces shall be done as specified for steel and other metal work.

PVC, Polythene, galvanised and Chromed Piping

Pipes and fittings manufactured from the above materials shall receive no treatment except as follows:-

(a) Exposed galvanised steel piping shall be thoroughly cleaned and coated with one layer of etching primer, one coat zinc chromate primer and finishing coats as for exposed steel piping when called for in the Schedule of Quantities.

(b) The exposed threads and where galvanising has been damaged shall be thoroughly cleaned and all traces of oil removed with an appropriate solvent. One coat of zinc chromate primer to SANS 679 Type 1 followed by one undercoat to SANS 681 Type II to a total dried film thickness of 50 µm shall be brush applied to all surfaces.

(c) Buried galvanised steel piping shall, when called for in the Schedule of Quantities, be protected by wrapping with pressure sensitive tape or butyl rubber laminated tape.

(d) Identification bands shall be painted on exposed PVC, Polythene and chromed piping in accordance with instructions of the Engineer.

M21.23.4 Flexible and Flanged Couplings

The couplings shall first be cleaned by removing all loose scale, rust, extraneous matter such as mud, by means of wire brushing and removing possible excess water by wiping with a dry cloth.

After cleaning, the whole of the coupling shall be well primed with a paste of saturated petroleum hydrocarbons (petrolatum), insert fillers and passivating agents, leaving a thin film on flanges and sleeves and a liberal amount around the bolt heads, narrow cavities, etc. A mastic plats of petrolatum, insert fillers and mineral fibres shall then be applied to cover all the bolt heads on the outside of the flanges (also between flanges to give approximate 5 mm cover over the sleeve). The mastic shall then be moulded up to, but not to completely cover the bolts and flanges.

A glass fibre, felt coated tape saturated with petrolatum with insert siliceous fillers shall then be applied circumferentially, starting and finishing on top of the coupling, care being taken to form the tape well into the angle between the flange and the pipe. Care shall be taken to smooth the tape down and ensure conformability to the underlying mastic. The tape should be "fed" onto the coupling and not stretched.

Two complete turns of 0,15 mm thick polyethylene sheeting shall be applied over the coupling. The sheeting shall be wide enough to cover the entire coupling and overlap by 150 mm on top of the coupling. The sheeting shall be secured onto the pipe barrel each side of the coupling by means of self adhesive tape overlapping 25 mm on the pipe barrel and 75 mm on itself.

The tendered unit rate for wrapped couplings shall include all materials, labour, transport, etc. to complete the protection of the coupling in any position along the pipeline.

M21.24 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

M21.25 TOLERANCES

Pipes shall be laid to the lines, grades and levels as specified on the Drawings

(a) Vertical deviation from the straight line between two consecutive levels shall not be more than the value of "d" as calculated from the following formula :-

$$d = 5 + \frac{L^{1/2}\ D^{1/2}\ S^{1/2}}{60}$$

Where : d = tolerance in millimetre
L = length of pipe between control point in millimetre
D = nominal pipe diameter in millimetre
S = slope of pipe taken as the difference in level of control points in millimetre divided by L

(b) The horizontal deviation from the specified direction and line between two consecutive control points shall not be more than the maximum vertical deviation as calculated under (a) above.

Pipe items and specials shall be manufactured to the dimensions as specified in the pipe lists or shown on the Drawings

Maximum allowable deviation from the specified dimensions shall be as follows:-

(a) Straight pipes and tapers :-

Length (mm)	Tolerance (face to face) (mm)
Up to 1 800	± 16
1 800 to 2 700	± 24
2 700 to 3 600	± 32
Longer than 3 600	± 40

(b) Bends and Tees :-

Diameter (mm)	Tolerance (centre to face) (mm)
Up to 300	16
300 to 600	24
600 to 1 200	40

M21.26 TESTING

M21.26.1 Steel Pipes and Pipe Fittings

M21.26.1.1 *Testing and Inspection at Manufacturer's Works*

Where factory inspection and supervision of tests are required by the Engineer, such tests and inspections shall be carried out at the manufacturer's works at the expense of the Contractor who shall provide free of charge all necessary testing facilities, labour, instruments, etc. that may be required.

An independent inspector such as the SABS may be appointed to act on behalf of the Engineer. Fees payable to such an inspector, however, will not be to the account of the Contractor.

M21.26.2 Non-Destructive Tests

(a) Visual Inspection

All pipes and pipe specials shall be visually examined, shall be free of defects, such as cracks, laminations and arc burns and shall comply fully with the dimensions as specified.

A penetrant dye shall be used for the visual inspection of welding.

(b) Ultrasonic Inspection

All longitudinal or spiral welds on straight steel pipes shall be checked ultrasonically with approved equipment capable of continuous and uninterrupted inspection of weld seam - all in accordance with API 5L.

(c) Radiographic Inspection

As an alternative to (b) above, 20% of all longitudinal or spiral welds on straight pipe, and up to 100% of all butt-welds on straight pipes and up to 100% of all welds for pipe specials shall be checked radio graphically in accordance with API 5L.

(d) Hydrostatic Testing

All pipes and pipe specials shall be subjected to hydrostatic testing at a test pressure determined from the following formula:-

$$P = \frac{1500\ Yt}{D}$$

Where P = Hydrostatic test pressure in kPa
Y = Minimum Yield stress of material in Mpa
t = Nominal wall thickness in mm
D = Nominal outside diameter in mm

All leaks on sweating shall be considered as defects.

(e) Visual Inspection of Linings and Coatings

Linings shall have a smooth glossy finish, free from ripples, runs, pinholes, bubbles, laminations, disbanding, fraying or other blemishes.

Coatings shall be free of crazing, laminations, disbanding, pinholes, craters, bridging across and weld beads, or any sign of physical damage and shall have an acceptable smooth finish.

(f) Holiday Testing of Linings and Coatings

The entire lining and coating of each pipe shall be tested by the Contractor to the Engineer's satisfaction with an approved holiday detector fitted with the following heads:

(i) For epoxy linings and coatings - with a wet sponge detector head.
(ii) For bitumen or coal tar linings and coatings - with a copper bristle search head.
(iii) For wrapped coatings - with a rolling ring detector around the pipe.

(g) Thickness of Linings and Coatings

The thickness of linings and coatings shall be measured by means of a magnetic or eddy current instrument suitable for measuring non-metallic films on curved magnetic surfaces.

(h) Delamination Test and Disbonded Areas

Refer to SANS 1178 Clauses 7.2.3 and 7.2.4.

M21.26.3 Destructive Tests

Destructive tests on steel pipes and specials shall be carried out in accordance with SANS 719 and SANS 1178.

M21.26.4 Testing and Inspection on Site

M21.26.4.1 Site Welding

The Contractor must appoint an inspector from a certified institution in accordance with SANS 044 Part V at his own cost. An incompetent inspector must be replaced by a competent person. A copy of all inspection reports must be provided at no cost to the Engineer.

Inspection and test of welds must be carried out in accordance with API Std 1104 chapter 5 and the standard required must be according to chapter 6. All results must be tabulated.

Radio graphical tests in accordance with chapter 8 of above specification must be carried out. The numbers of welds of each welder that must be tested are: the first three joints, then every third joint to a total of 6 joints and then one out of every 10 joints. Should one joint fail the prescribed tests, the above procedure must be repeated starting from the before last joint.

The Contractor must keep a complete record of the position of every radio graphical tested joint and provide a copy at no cost to the Engineer.

All joints, which fail the prescribed test of API Std 1104, must be repaired in accordance with chapter 7 of above specification.

M21.26.4.2 Linings and Coatings

Linings and coatings shall be visually inspected on Site prior and after installation for any sign of physical damage.

All repairs to linings and coatings undertaken on Site shall be to the Engineer's approval who also reserves the right to order pipes and pipe specials to be returned to the factory for repairs to linings and coatings.

For bitumen linings and coatings the following procedure shall be followed:-

Weld spatters must be removed and steel surfaces must be wire brushed to ST 3 of SIS 0559 and all dust must be removed. Damaged bitumen primers, bitumen and lime layers must be scraped and/or brushed until steel or good bitumen is reached to a point at least 100 mm from the point of repair.

Bitumen primer must be cold applied to steel and exposed bitumen surfaces and left to dry for at least 4 hours but not more than 4 days.

For the repair of linings bitumen applied hot in an acceptable manner shall be used.

One layer of warm bitumen to a thickness of 1.5 mm followed by two layers bitumen saturated glass fibre cloth applied by means of a warm iron to ensure complete affixion and bitumen saturation must be applied as wrapping. Above must be followed by one layer of 1 mm thick warm applied bitumen on one layer of white lime over the joint area. The thickness of the wrapping must be at least a thick as the original and edges must fit to the original protection.

Bitumen must be heated in closed kettles to a maximum of 235EC. Local overheating must be prevented by stirring.

M21.26.4.3 Hydrostatic Testing of Pipe Line

Pipe joints shall in general be left exposed until the pipeline has been successfully tested and passed by the Engineer. All open excavations at joints shall be adequately and safely protected. Should the Engineer order any joints to be backfilled prior to testing, the responsibility for re-exposing the joints for the purpose of repair of leaks after testing shall be entirely the Contractor's own and he shall not be entitled to extra payment for such work.

The Contractor shall provide and maintain in good condition the equipment necessary to carry out the test. Where temporary pumping equipment is used for testing, the equipment shall consist of a force pump with the suction end in a suitable container of water, and connected to the pipe line by means of high pressure hosing in good condition and/or piping and all the necessary flanges, connections, couplings, etc. and a pressure gauge suitably calibrated and in good condition. The equipment and method of assembly for testing shall be subject to the approval of the Engineer.

The entire pipe line or portion of the pipe line between closed valves and/or blank flanges mat be tested at any one time provided that no section of the pipe line is subject to a higher pressure than one and a half times the working pressure for the particular class of pipe and fitting.

Prior to commencing the test the Contractor may, if he so desires, keep the pipeline full of water for as long a period as he considers necessary. The Contractor shall, at least 14 days prior to the first test being carried out, submit full details of the procedure he intends to follow, to the Engineer for approval.

For the purpose of the test the pipeline shall be filled with water in such a manner that no shock

is created or air trapped in the portion to be tested.

Once the pipe line is completely full of water, the pressure shall be brought up to one and a half times the maximum working pressure for all parts of the portion of pipe line under test as the water level in the container at the suction end of the pump noted. The initial application of the test pressure shall be done in the presence of the Engineer.

The pressure shall be maintained at the test level for 4 hours.

The quantity of water which has to be added to the container at the suction end of the pump during the 4 hours that the pipe line is under test in order to bring the water level back to the initial level at the start of the test, shall be carefully recorded. No water may be added to the container except in the presence of the Engineer.

Should the quantity of water thus added not exceed the following limit, the pipeline shall be deemed to be successfully tested.

Limit of leakage permitted over 4 hours:-

(a) For pipeline with flexible joints

50 ml per 10 mm of pipe diameter per 1 000 m of pipe length per 10 m maximum test head for the portion of pipeline tested. All joints must be inspected while the test is in progress to ensure that there are no visible leaks.

(b) For pipeline with welded joints

10 ml per 10 mm pipe diameter per 1 000 m of pipe length per 10 m maximum test head for the portion of pipeline tested. Should the leakage be more than 3 l/km of pipe tested, the Contractor must prove that no single leak exceeds 0,2 l in 4 hours.

M21.26.5 Other Pipe Materials

Visual inspections and hydrostatic tests shall be carried out on Site as described for steel pipes. Factory inspections and tests shall be as specified in the relevant SANS Specification for the pipe material concerned.

M21.27 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete pipework system installation as specified. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of drawings and instructions for anything not specifically mentioned but obviously required for the proper installation to enable the system as described to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned

City of Johannesburg
Johannesburg Water (SOC) Ltd

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – E11 : Electrical Earthing and Lighting Protection**

JW Reference: **BWW523C**

Document Ref. No: **E11**

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
Reviewed	Director	R Baard	August 2019	
Approved	Regional Maintenance Manager	T Thabeng	August 2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
5	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
4	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
3	2012-05-30		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
2	2010-05-03		Review Electrical Standards
1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E11: GENERAL ELECTRICAL GENERAL EARTHING AND LIGHTNING PROTECTION

CONTENTS

E11.1 SCOPE ... 3

E11.2 STATUATORY DOCUMENTS AND STANDARDS ... 3
E11.2.1 Standards ... 3
E11.2.2 Particular Specifications to be read in conjunction with this Specification ... 3

E11.3 CERTIFICATE OF COMPLIANCE ... 4
E11.3.1 New or modified installations ... 4
E11.3.2 Maintenance of installations ... 4

E11.4 PROTECTION MEASURES ... 4
E11.4.1 Protection measures to reduce injury of living beings by electric shock ... 4
E11.4.2 Lightning Protection System (LPS) to reduce physical damage ... 4
E11.4.3 Surge Protection Measures (SPM) to reduce failure of electrical and electronic systems ... 4

E11.5 RISK MANAGEMENT ... 4

E11.6 EXTERNAL LIGHTNING PROTECTION SYSTEM (LPS) ... 5
E11.6.1 Design of the LPS ... 5
E11.6.2 Air-termination systems ... Error! Bookmark not defined.
E11.6.3 Down-conductor systems ... 6
E11.6.4 Earth-termination system ... 6
E11.6.5 Components ... 7

E11.7 LPS FOR STRUCTURES WITH A RISK OF EXPLOSION ... 7

E11.8 INTERNAL LIGHTNING PROTECTION SYSTEM (LPS) ... 8
E11.8.1 Equipotential bonding ... 8

E11.9 INSPECTION AND MAINTENANCE OF LPS ... 9
E11.9.1 Inspection ... 9
E11.9.2 Maintenance ... 9

E11.10 INJURY TO LIVING BEINGS DUE TO TOUCH AND STEP VOLTAGES ... 9
E11.10.1 Touch voltage ... 9
E11.10.2 Step voltage ... 9

E11.11 SURGE PROTECTION MEASURES (SPM) ... 10
E11.11.1 Design and installation of SPM ... 10
E11.11.2 Earthing and bonding ... 10
E11.11.3 Magnetic shielding and line routing ... 10
E11.11.4 Coordinated SPD system ... 10
E11.11.5 SPM management ... 11

E11.12 EARTHING OF THE LV DISTRIBUTION SYSTEM ... 11
E11.12.1 TN-S system earthing – Separate neutral and protective conductors ... 11
E11.12.2 Requirements of the TN-S system earthing ... 12
E11.12.3 Installation of the TN-S system earthing ... 12

E11.14 LIGHTNING PROTECTION SYSTEM (LPS) ... 13

E11.15 MEASUREMENT AND PAYMENT ... 14

E11.1 SCOPE

This specification covers the detail requirements of the general protection against lightning to be installed under the contract, including:

a) General notes on the lightning protection measures;

b) The risk management and definition of the risk to a structure due to lightning strikes;

c) A Lightning Protection System (LPS) describing principles to be followed for the protection against physical damage to a structure including the installations within the structure as well as injury to living beings due to touch and step voltages;

d) Surge Protection Measures (SPM) to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).

e) Information for the design, installation, inspection, maintenance and testing of the above.

E11.2 STATUATORY DOCUMENTS AND STANDARDS

E11.2.1 Standards

The latest edition, including all amendments up to date of tender of the following particular national and international specifications, publications and codes of practice which shall be read in conjunction with this specification and shall be deemed to form part thereof:

a)	SANS 10142-1	The wiring of premises Part 1: Low-voltage installations.
b)	SANS 10142-2	The wiring of premises Part 2: Medium-voltage installations above 1 kV ac not exceeding 22 kV ac. and up to and including 3 MVA installed capacity.
c)	SANS 62305-1	Protection against lightning Part 1: General principles
d)	SANS 62305-2	Protection against lightning Part 2: Risk management
e)	SANS 62305-3	Protection against lightning Part 3: Physical damage to structures and life hazard
f)	SANS 62305-4	Protection against lightning Part 4: Electrical and electronic systems within structures.
g)	SANS 62561	Lightning protection system components (LPSC).
h)	SANS 1063	Earth rods, couplers and connections.
i)	SANS 10199	The design and installation of earth electrodes.
j)	SANS 10313	Protection against lightning — Physical damage to structures and life hazard.
k)	SANS 10292	Earthing of low-voltage (LV) distribution systems.

E11.2.2 Particular Specifications to be read in conjunction with this Specification

The following particular specifications shall be read in conjunction with the Project Specification:

a) Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

E11.3 CERTIFICATE OF COMPLIANCE

E11.3.1 New or modified installations

The Contractor shall appoint a competent and experienced lightning protection design engineer for the design, supply, installation, inspection and testing of the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM).

After installation and testing of the LPS and SPM, the lightning protection design engineer will issue a Lightning Protection System Installation Safety Report as prescribed in SANS 10313: Annex A as well as SANS10142-1, for each area of protection. The Engineer will witness the installation as well as all tests conducted.

Two copies of this report shall be submitted to the Engineer before handing over of any repair, modification or new installation involving LPS or SPM systems.

E11.3.2 Maintenance of installations

The Client shall appoint a competent and experienced lightning protection engineer to maintain and inspect the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM) on an annual basis. Tests and inspections should be done prior to the start of the lighting season.

The lightning protection engineer will issue a Lightning Protection System Maintenance Certificate as prescribed in SANS 10313: Annex B, for each area of protection.

E11.4 PROTECTION MEASURES

The following protective measures should be installed as far as possible. The most suitable protective measure shall be selected during the design phase, considering technical and economic aspects based on a risk assessment.

E11.4.1 Protection measures to reduce injury of living beings by electric shock

a) Adequate insulation of exposed lightning conductive parts;

b) Equipotential bonding of equipment and conductive parts and connection to a meshed earthing system;

c) Physical restrictions and warning notices where the above is not achievable.

E11.4.2 Lightning Protection System (LPS) to reduce physical damage

a) Air-termination system on high points;

b) Down-conductor system;

c) Earth-termination system;

d) Equipotential bonding;

E11.4.3 Surge Protection Measures (SPM) to reduce failure of electrical and electronic systems

a) Earthing and bonding measures;

b) Magnetic shielding;

c) Line routing;

d) Isolating interfaces;

e) Coordinated Surge Protection Device (SPD) system.

E11.5 RISK MANAGEMENT

Risk to a structure exposed to lightning flashes is managed by a process based on risk evaluation or assessment. Appropriate protection measures are selected to reduce the risk to or below the tolerable limit.

The following basic procedure must be followed during the risk assessment:

a) Identification of the structure to be protected;

b) Partitioning of the structure into zones;

c) Identification of all the types of loss in the structure;

d) The identification and calculation of the corresponding risk components for each type of loss;

e) Evaluation of need of protection;

f) Selection of protective measures (LPS, SPM or other protection measure);

g) Evaluate the cost-effectiveness of the protection measures;

h) Re-evaluation of the corresponding risk components and the need for further protection.

The risk assessment and the evaluation of loss and risks as well as protection selection must be done by a competent and experienced lightning protection design engineer. It is the responsibility of the contractor to appoint a lightning protection design engineer for this purpose.

E11.6 EXTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An external LPS is installed on a structure to intercept a direct lightning flash to the structure, conduct the lightning current safely towards earth and to disperse the lightning current into the earth. It consist out of an air-termination system, a down-conductor system and an earth-termination system.

E11.6.1 Design of the LPS

The design of the LPS must be done in accordance with SANS 62305-3 with specific reference to Annex E.

The LPS should be designed and installed by competent and experienced LPS design engineer and LPS installer (person who is competent to install, construct and test an LPS for compliance with this SANS 10313). It is the responsibility of the contractor to appoint a competent and experienced LPS design engineer and installer. The Contractor is responsible to manage consultation between the various parties involved in the project (client, local authorities, LPS design engineer, LPS installer, architect, civil contractor/builder and electrical engineer). In new structures, the LPS should be installed during the construction phase; proper timing for soil resistivity test and the design of the LPS is of utmost importance.

The LPS design engineer and installer will be responsible for the quality assurance on the project.

E11.6.2 Isolated LPS

On structures at risk of explosion and fire an isolated external LPS must be installed.

E11.6.3 Air-termination systems

Air-termination systems can be composed of any combination of the following elements:

a) Rods (including free-standing masts);

b) Catenary wires;

c) Meshed conductors.

Air terminals installed shall be located at corners, exposed points and edges on a structure. To determine the exact location one or more of the following methods should be followed:

a) Protection angle method;

b) Rolling sphere method;

c) Mesh method.

All types of air terminals shall comply in full with SANS 62305-3. The positioning of air termination system shall comply with SANS 62305-3 (Annexure A).

All air-termination components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

E11.6.4 Down-conductor systems

If the air-termination system is supported by one or more non-conductive columns, at least one down-conductor is required for each column. Steel columns do not require additional down-conductors.

All down-conductor components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

Down conductors may be placed on the surface of non-combustible walls. On structures at risk of explosion and fire, all down conductors must be isolated from the structure walls.

E11.6.5 Earth-termination system

For lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems).

An earthing resistance not exceeding 3Ω (measured at low frequency) is required for earth termination systems. Should it be impossible to achieve this earthing resistance value, the Engineer must approve the value obtained and deemed reasonable.

Type A earthing arrangement

Each down connector is connected to a horizontal or vertical earth electrode installed outside the protected structure. A minimum of two earth electrodes will be installed, buried at an upper end depth of minimum 0.5 m with a separation distance to minimize electrical coupling effects in the earth. The minimum length of the earth electrodes will be calculated during the design phase, based on the soil resistivity.

Type B earthing arrangement

A ring conductor is installed external to the protected structure, buried at an upper end depth of at least 0.5 m and at a distance of about 1 m away from the external walls. The radius of protection will be calculated during the design phase, based on the soil resistivity. Additional electrodes should be added to obtain the desirable protection radius. The number of electrodes shall not be less than the number of down conductors (with a minimum of two electrodes).

Test points

A test point must be installed at the connection between each down-conductor and earth termination electrodes. The joint will only be opened for testing and will remain closed at all times.

Conductor connections

Conductor connections shall be made secure by exothermic welding. Clamping or bolting of conductor connection points shall only be accepted with permission from the Engineer. All points of connection must be covered with a cold applied anti-corrosion and sealing tape based on a synthetic fabric, impregnated and coated with a neutral petrolatum compound.

E11.6.6 LPS Installation

Type B earthing will be installed as the preferred arrangement. Type A earthing will only be accepted with prior approval from the Engineer (in writing). The installation of the earth electrodes will be inspected and approved by the Engineer during the construction phase.

The LPS shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1. Where an installation may typically consist of a main building or plant and one or more satellite subsystems, the various earth networks shall be interconnected to form one earth system. Only in the rare instance of a subsystem being totally isolated, with no cables, pipes, fences or other conductive structures connecting it to the rest of the installation, may a system be provided with a separate earth network.

E11.6.7 Components

All material and components used in a LPS must conform to the requirements specified in SANS 62561.

Minimum cross-sectional area of conductors

a) Air-termination conductors, air-termination rods and down-conductors:

Configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors are given in SANS 62305-3: Table 6 “Material, configuration and minimum cross-sectional area of air-termination conductors, air-termination rods, earth lead-in rods and down-conductors”.

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	**Configuration**	**Cross-sectional area (sq. mm)**
Aluminium	Solid tape	70
	Solid round	50
Stainless steel	Solid tape	50
	Solid round	50

Table 1: *Specific configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors.*

b) Earth conductors and electrodes:

Configurations and minimum dimensions of earth electrodes are given in SANS 62305-3: Table 7 “Material, configuration and minimum dimensions of earth electrodes”.

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	**Configuration**	**Dimensions**	
		Earth rod diameter (mm)	**Earth conductor (sq. mm)**
Copper coated steel	Solid round	14	
Stainless steel	Solid round	15	78
	Solid tape		100

Table 2: *Specific configurations and minimum dimensions of earth conductors and electrodes*

E11.7 LPS FOR STRUCTURES WITH A RISK OF EXPLOSION

The design, construction, extension and modification of lightning protection systems for structures with a risk of explosion must comply with SANS 62305-3: Annex 3.

a) The LPS must be isolated from the structure. This includes the air termination conductors as well as all down conductors. Under no circumstances may any parts of the structure be used as part of the LPS

b) The distance between down conductors will not exceed 5m. The down conductor count and spacing will be determined during the design phase with a minimum of two down conductors installed.

c) The earth-termination system will be a type B arrangement

d) All installations/structures/equipment will be equipotential bonded to the lightning protection system. Junctions shall be provided for the joining of connection and earthing leads to containers, metal construction parts, drums and tanks

e) Aboveground metal piping shall be earthed at least every 30 m. Bonding conductors will

be connected to the piping at tap holes in the flanges for taking up screws. Where this is not possible, welded-on lugs or bolts will be used

f) Such devices shall be suitable for the environment in which they are installed.

The above will be applicable to aeration basins, bioreactors, HOW, digester (high risk areas)

E11.8 INTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An internal LPS is intended to prevent flashover between electrically conducting elements within the structure and the external LPS components using either equipotential bonding or an adequate separation distance.

E11.8.1 Equipotential bonding

All equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

Bonding bar

A single bonding bar shall be installed for equipotential bonding. The bar shall be manufactured from electrical grade hard drawn aluminium 80sq mm complete with mounting insulators. The bar will be pre-drilled with ten M8 holes, fitted with stainless steel high tensile hex bolts with nuts and washers. The bar will be fitted with two removable test links, one on each end of the bar.

The bonding bar shall be connected to the earth-termination system at two connection points with two separate cables.

A ring bonding bar where more than one interconnected bonding bars are installed can be used for larger installations.

External conductive parts

External conductive parts shall be bonded to the bonding bar from a point as near as possible to the point of entry into the structure. This will include all electrical conductive pipes, cable ladder, fences and gates.

External electrical lines

Live conductors shall be bonded to the bonding bar via SPD's. (See Paragraph E11.1 Surge Protection Measures). All gland plates in electrical panels will be bonded to the earth network. Power cable armouring shall be bonded to the earth network at both ends of the cable via the cable glands on the gland plates.

Telecommunication and Instrumentation lines

Please refer to Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

Internal systems

Screened cables installed in the internal system must be bonded to the bonding bar via the screen. Cables in metal conduits installed in the internal system must be bonded to the bonding bar via the conduits. Unscreened cables must be connected to the bonding bar via SPD's (See Paragraph E11.1 Surge Protection Measures).

Bonding conductors

Bonding conductors shall be short and shall run in straight or smoothly contoured routes. Material, dimensions and conditions of use shall comply with SANS 62305-3. The minimum cross-section for bonding components shall comply with SANS 62305-4 Table 1 "Minimum cross-sections for bonding components".

The following material and dimensions will be specifically applicable.

Bonding component	Material	Cross-section (sq. mm)
Bonding bars	Aluminium	80
Bonding to LPS	Aluminium	70
Connecting conductors from internal metal installations to bonding bars (carrying a partial lightning current)	Aluminium	70

Table 3: *Specific material and cross-section area for bonding components*

E11.9 INSPECTION AND MAINTENANCE OF LPS

E11.9.1 Inspection

Inspections should be conducted during the construction period as well as after completion of the installation. A Lightning Protection System Installation Safety Report as described in SANS 10313 Annex A (or similar) must be issued by the LPS installer after completion of the installation. All tests conducted during the commissioning of the LPS must be witness by the Engineer. Inspections must be conducted after any alteration or repair of the LPS.

Regular periodic inspections must be conducted on the LPS system of explosives facilities. A maintenance and inspection plan shall be developed for the installed protection systems. The system shall be tested every 12 months. A register shall be kept for this purpose. Only qualified personnel having the necessary training and expertise shall be permitted to maintain, inspect, test and sign off these facilities.

E11.9.2 Maintenance

Routine inspections should be conducted on a 12-monthly basis. Any observed faults must be repaired immediately.

E11.10 INJURY TO LIVING BEINGS DUE TO TOUCH AND STEP VOLTAGES

The area surrounding the down-conductor (within a 3-meter radius) may be hazardous despite measures described in this specification. Additional measure must be installed to reduce this risk to acceptable values:

E11.10.1 Touch voltage

a) The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or

b) The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or

c) Increasing the contact resistance of the soil to above 100kΩ, or

d) The down conductors are insulated against the lightning impulse (100 kV, 1, 2/50 µs impulse withstand voltage).

E11.10.2 Step voltage

a) The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or

b) The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or

c) Increasing the contact resistance of the soil to above 100kΩ, or

d) The down conductors are insulated against the lighting impulse (100 kV, 1,2/50 µs impulse withstand voltage), or

e) The installation of a meshed earth-termination system.

E11.11 SURGE PROTECTION MEASURES (SPM)

Surge Protection Measures (SPM) are implemented to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).

Equipment failure due to LEMP is caused by surges conducted by connected wiring or by radiated electromagnetic fields. The effect of line surges is reduced by the installation of Surge Protection Devices (SPD's). The effect of radiated electromagnetic fields is reduced by shielding of equipment and shielded lines. Equipment generally complies with EMC product standards, which is sufficient to protect such equipment against LEMP.

E11.11.1 Design and installation of SPM

The SPM should be designed, installed and signed off by a competent and experienced SPM design engineer and SPM installer (person who is competent to design, install, construct and test an SPM with a broad knowledge of Electromagnetic compatibility (EMC)). It is the responsibility of the contractor to appoint a competent and experienced SPM design engineer and installer.

The design of the Surge Protection Measures (SPM) must be done in accordance with SANS 62305-4 as well as the Risk Assessment study done as described in SANS 62305-2.

E11.11.2 Earthing and bonding

A meshed network with a 5m mesh width is installed around the structure. This mesh is connected to the Type B ring earth electrode as well as the structure's interconnected mesh reinforced concrete floor to form a meshed earth termination system. The earth-termination systems of all internal systems should be bonded together to prevent potential differences between the systems.

Bonding bars in a stand-alone or ring configuration should be used to bond all conductive parts and incoming services (metal pipes, power lines, signal lines) together. Incoming lines should be bonded with SPD's. The material and minimum cross-sections for bonding component must comply with SANS 62305.

E11.11.3 Magnetic shielding and line routing

Spatial shielding is used to define protections zones. It can be grid like and can use electrical conductive reinforcement in the building. Internal lines can comprise of shielded cables or metallic enclosures of cables. Cables must be routed close conductive parts in the shielding system (reinforced concrete) to minimise induction.

The requirement of SANS 62305 concerning the material and minimum cross-sections or thickness of air-termination and down conductors must be followed.

E11.11.4 Coordinated SPD system

Please read this section in conjunction with the document Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection for system compatibility.

The principle of a coordinated SPM is based on the division of the protected area/s into Lighting Protection Zones (LPZ), where the first LPZn is the overall protection zone which borders the inner zone LPZ (LPZn+1). The effect of the LEMP is reduced with each zone employed. LPZ 0 is the unprotected outer zone where equipment will be exposed to full LEMP and lighting surge currents. LPZ 1…n is the inner zones where equipment is exposed to limited surge current and attenuated electromagnetic field. (Refer to SANS 62305-4 typical drawings.)

SPD's must be selected to reduce the surge overvoltage between the live conductors and earth to a value lower than the equipment's rated impulse withstand voltage U_W at its terminals (common mode withstand voltage). The type of SPD, the location of the SPD (as close as possible to the point of entrance of the line vs as close as possible to the equipment to be protected) as well as the connecting conductors must be considered.

Types of SPD's:

There are three types of SPD's:

a) Type 1 SPD

The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage. It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors. Type 1 SPD is characterized by a 10/350 µs current wave.

b) Type 2 SPD

The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads. Type 2 SPD is characterized by an 8/20 µs current wave.

c) Type 3 SPD

These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads. Type 3 SPD is characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

E11.11.5 SPM management

A Management Plan must be implemented by a competent and experienced SPM design engineer:

a) Risk analysis;
b) SPM planning;
c) SPM design;
d) Installation of the SPM;
e) Approval of the SPM;
f) Recurrent inspections (documented);
g) Maintenance (following defects noted during recurrent inspections).

E11.12 EARTHING OF THE LV DISTRIBUTION SYSTEM

E11.12.1 TN-S system earthing – Separate neutral and protective conductors

The protective conductor (PE) is a separate conductor connected to the transformer neutral (star point).The transformer neutral is connected to the structure earth-termination system.

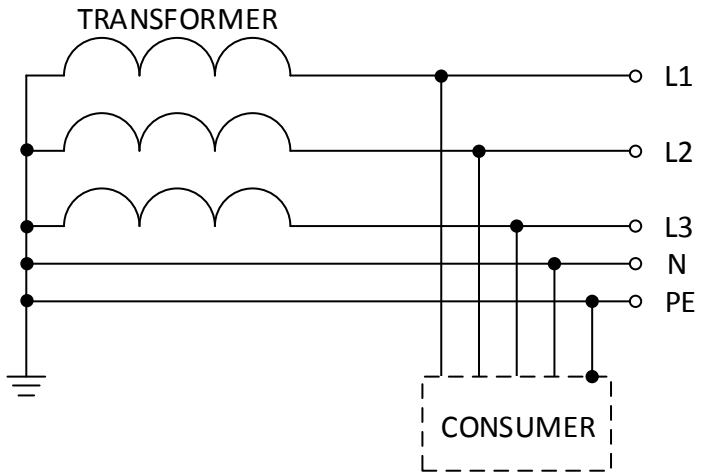


Figure 1. *TN-S System earthing*

E11.12.2 Requirements of the TN-S system earthing

a) In a single-phase TN-S system, the equivalent area of the neutral (N) conductor should be not less than the area of the phase conductor.

b) In a three-phase TN-S system, the equivalent area of the N conductor should be not less than half the area of one phase conductor.

c) In a three-phase TN-S system, all power cables will be four core, with the fourth (black) core used as the N conductor.

d) The protective earth (PE) conductor shall be able to carry the maximum fault current for the duration of the fault. This applies to any point in the distribution system.

e) The PE conductor should be of copper not less than $10mm^2$.

f) The minimum cross-sectional area of the PE conductor for phase conductors $16mm^2$ to $35mm^2$ is $16mm^2$.

g) The minimum cross-sectional area of the PE conductor for phase conductors above $35mm^2$ is at least 50% of the phase cross-sectional area.

h) No mechanism (circuit breaker, disconnector, fuse or removable link) which can separate the neutral conductor from the neutral point may be installed.

E11.12.3 Installation of the TN-S system earthing

a) The PE conductor will be installed next to the associated LV power cable.

b) Where the PE conductor is installed directly in the ground, bare copper earth wire will be used.

c) Where the PE conductor is installed in a covered cable trench or on a cable rack, black PVC insulated earth wire will be used. Both ends of the PE conductor will be identified with yellow/green crimp sleeves.

E11.14 LIGHTNING PROTECTION SYSTEM (LPS)

Figure 2 shows a typical LPS as implemented by Johannesburg Water

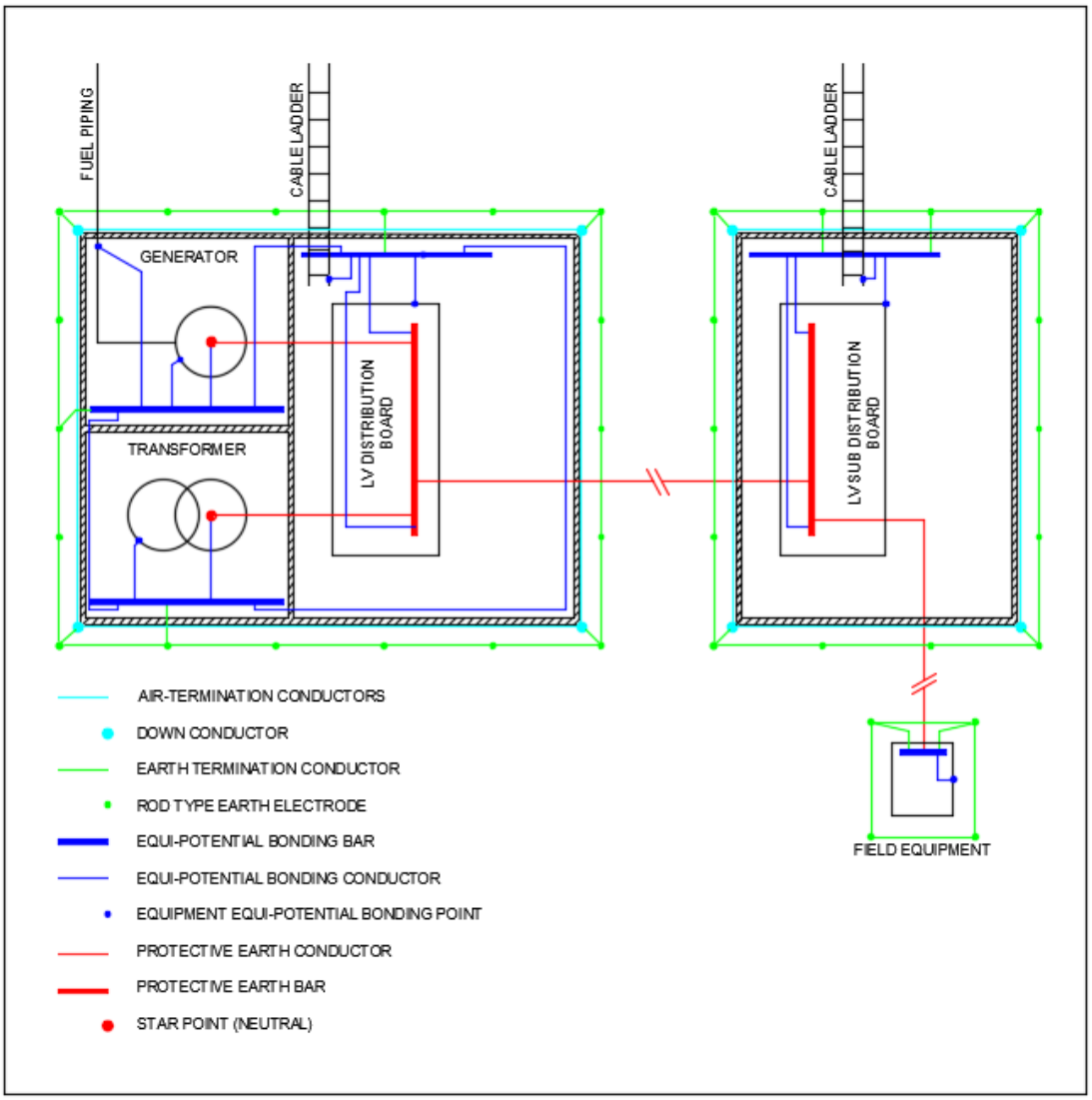


Figure 2. *Lighting Protection System (LPS)*

E11.16 MEASUREMENT AND PAYMENT

Item	Unit
Earth resistivity tests	No

The tendered rate shall include for the carrying out of the earth resistivity tests by a competent and experienced LPS engineer. The unit for measurement shall be per point where such tests have to be carried out.

Item	Unit
Design of a Lightning Protection System (LPS)	No

The tendered rate shall include for the design by a competent and experienced LPS engineer and must include the design of the Surge Protection Measures (SPM). The unit for measurement shall be an area of design.

Item	Unit
Installation of a structure LPS	Sum

The tendered rate shall include full compensation for the supply of all material required and the installation of the Lighting Protection system as per the design by a competent and experienced LPS engineer. It shall include for the testing of the LPS by a competent and experienced LPS engineer.

Item	Unit
Extra over for the supply and installation of additional rod type earth electrodes of specified length including welding/clamps for the connection of earth-termination conductors	No

The tendered rate shall include full compensation for the supplying and installation of the earth electrodes.

Item	Unit
Provision for additional earthing as required	Provisional sum

The provisional sum provided shall include for any additional earthing which may be specified by the Engineer after the acceptance of the contract.

The Contractor shall submit a written quotation to the Engineer when requested to by the Engineer and shall not commence with the installation of any additional earthing without the written instruction of the Engineer.

Item	Unit
Testing of a LPS	No

The unit of measurement shall be the number of tests undertaken by a competent and experienced LPS engineer, including the supply of the equipment required to do the test.