

## **TENDER DOCUMENT FOR**

### **OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMESUPGRADE: REPLACEMENT OF PIPELINES AND REFURBISHMENT OF WATER TREATMENT WORKS:**

- A. *SPECON PIPELINE REPLACEMENT PHASE 3***
- B. *REFURBISHMENT OF OLIFANTSPOORT WATER TREATMENT WORKS***
- C. *REHABILITATION OF MEGORING AND THAKGALANG RIVER CROSSINGS***

### **VOLUME 1 - BOOK 2: SCOPE OF WORK, TECHNICAL SPECIFICATIONS AND SITE INFORMATION**

**CLOSING: 24 MARCH 2023**

**TENDER NUMBER: GTAC 006-2022-23**

#### **SUPPLY CHAIN**

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## Structure of Tender and Contract Document

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| <b>Volume 1</b> | Document 1 of 2: Tender Procedures and Contract                                                      |
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## LEPELLE NORTHERN WATER

**BID No.: GTAC 006-2022-23**

**UPGRADE OF THE OLIFANTSPOORT AND EBENEZER WATER  
SUPPLY SCHEMES: REPLACEMENT OF PIPELINES AND  
REFURBISHMENT OF WATER TREATMENT WORKS**

**PORTION 2: CONTRACT**

**PART C3: SCOPE OF WORK**

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## C3.1 DESCRIPTION OF WORKS

### C3.1.1 EMPLOYER'S OBJECTIVES

The water supply to Polokwane and surrounding areas has been severely constrained for over a decade, affecting the reliability of water services for human consumption and economic development of the area. Various projects and initiatives have been planned and implemented over the past years to address the acute water shortages experienced by the communities in the region.

The stability of the water supplies is further compromised by a poor and deteriorating condition of the critical bulk conveyance and storage infrastructure components of the Olifantspoort and Ebenezer Water Supply Schemes. Refurbishment or replacement of some critical infrastructure components of the two schemes is urgently required to stabilise the existing water supply by eliminating or significantly reducing the occurrence of water supply disruptions due to breakdowns.

### C3.1.2 OVERVIEW OF THE WORKS

The works consist of three separate sub-projects spread over four locations, as described in the following paragraphs.

#### C3.1.2.1 SPECON PIPELINE REPLACEMENT PHASE 3

A project layout plan is attached as part of the Project Drawings showing the work required for the construction of a 7 km long 800 mm ND steel pipeline to replace a section of the existing rising main from Pump Station PS1 to Specon Reservoirs which has deteriorated over the years due to severe metal loss and is now prone to very frequent pipe bursts. The scope of work for this work package includes the following activities:

- Excavation to expose existing 800mm ND continuously welded steel pipelines, cutting into pipelines, recovery, loading and transportation of recovered pipes to PS2 Pump Station in Lebogakgomo.
- Demolishing existing reinforced concrete air and scour valve chambers and recovery and transportation to PS2 Pump Station in Lebogakgomo of recovered fittings. Disposal of rubble at approved dumping sites.
- Excavation, bedding, supplying, laying, jointing, testing and back filling continuously welded 800mm ND Grade X42 steel pipes with 6 mm wall thickness and 8 mm wall thickness at river and road crossings.
- Installation of pipe sleeves across a provincial road.
- Construction of reinforced concrete valve chambers complete with all valves and pipe specials as indicated on construction drawings:
  - Air Valve Chambers: 150 mm ND PN25 double orifice, dual action air release / vacuum break valves to be installed at locations indicated on construction drawings.
  - Scour Chambers: 350 mm ND PN25 wedge gate valves complete with pipe fittings as indicated on drawings.
  - Non-Return Valve: 600 mm ND PN25 Nozzle Type complete with complete with pipe fittings as indicated on drawings.
- Connection to the existing infrastructure.



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### C3.1.2.2 REFURBISHMENT OF THE OLIFANTSPOORT WATER TREATMENT WORKS (WTW)

The work package involves the refurbishment of the existing Olifantspoort WTW which is located on the Olifants River, approximately 30 km south-east of Lebowaikgomo, in Lepelle Nkumpi Local Municipality (LM), Limpopo Province. The project entails the modification of the existing works to enable an increased flow throughput while maintaining acceptable water quality standards. The refurbishments include the following:

- Installation of a lime dosing system to achieve pH<sub>s</sub> (saturation pH in terms of calcium carbonate) quality of the final water and thereby protect downstream infrastructure.
- The upgrading of the polyelectrolyte dosing station.
- Modification of the rapid mix / flocculation channel on module 1 to achieve floc development at a higher flow rate.
- Modification of the sedimentation basin in Module 1 to achieve higher flow rates and improved clarification. Replacement of sludge discharge valves.
- Modification of the sedimentation basin on Module 2 to support an increased through flow.
- Upgrading of all the filter valves to actuator operation.
- Replacement of 50% of the filter sand with anthracite media requiring the raising of the filter overflow walls by 250 mm.
- Refurbishment of the post-chlorination dosing system.
- Upgrading of the WTW Control & Instrumentation system to facilitate improved operator controls and measurement.

### C3.1.2.3 REHABILITATION OF MEGORING AND THAKGALANG RIVER CROSSINGS

The scope of work involves the rehabilitation of gravity mains, fed from the Rustfontein reservoir complex, at two river crossings. The sections of the pipelines were exposed due to severe soil erosion and face imminent danger of collapse.

#### Megoring River Crossing

The two 600 mm ND LNW gravity pipelines run parallel to a Polokwane LM raw water main from Dap Naude Dam, with sections of LNW pipeline dangerously exposed over a gully. The Polokwane M pipeline is not exposed, but the construction activities to rehabilitate LNW pipelines must be carefully executed to avoid compromising the Polokwane LM pipeline.

#### Thakgalang River Crossing

A section of LNW 600 mm ND gravity main between chambers GA95 and GA96 and the Polokwane LM raw water pipeline crossing the Thakgalang River are exposed due to damaged concrete encasement in the river bed.

The scope of work for this work package involves the following construction activities:

- Collection (including handling and loading) 18.3m long x 800 mm ND steel pipes, 10mm wall thickness, epoxy lined and metal primer base coated bypass pipes, fittings and precast concrete pedestals from PS2 Pump Station in Lebowaikgomo, transport to site and offloading.
- Cut ends of 800 mm ND steel pipes and fittings (which were cut using cutting torches during dismantling of previous temporary bypasses) and prepare them for jointing, supply of additional fittings and installation of temporary bypasses on precast concrete pedestals as indicated on



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drawings. Joining of the pipes will be by welding or fully restrained mechanical couplings. The mechanical couplings from previous LNW projects will be used. Contractors will be required to replace missing or damaged bolts, nuts and rubber seals where required.

- Pipes for the temporary bypass pipelines laid above ground will be laid on precast concrete plinths to be collected from PS2 Pump Station in Lebowakgomo. The Contractor is required to collect and transport the plinths from PS2 Pump Station in Lebowakgomo to site, offload and install the plinths, including the required excavations and the supply of a 6mm thick neoprene membrane below the pipes to protect the pipe surfaces that will be in direct contact with the precast concrete plinths.
- Dismantling of temporary bypasses, loading, delivery of temporary 18.3m long x 800 mm ND steel pipes, 10mm wall thickness, epoxy lined and metal primer base coated bypass pipes, fittings and precast concrete pedestals to, and offloading at PS2 Pump Station in Lebowakgomo.
- Excavation to expose existing 600mm ND continuously welded steel pipelines, cutting into pipelines, recovery, loading and transportation of recovered pipes to PS2 Pump Station in Lebowakgomo.
- Demolishing existing reinforced concrete air and scour valve chambers and recovery and transportation to PS2 Pump Station in Lebowakgomo of recovered fittings. Disposal of debris at approved dumping sites.
- Excavation, bedding, encasement in concrete, supplying, laying, jointing, testing and back filling for approximately 420m in length of 600 mm ND continuously welded Class X42 steel pipes with 8 mm wall thickness:
  - The pipes shall be internally lined with Cement Mortar lining (CML) in accordance to DWS 9900
  - Refer to Particular specifications PSCL for the external coating options:
  - Construction of the of the following reinforced concrete valve chambers:
  - Air Valve Chambers: 100 mm ND PN25 and PN40 double orifice, dual action air release / vacuum break valves
  - Scour Valve Chambers: 200mm ND flanged PN25 and PN40 wedge valves and 400mm ND flanged PN25 and PN40 double eccentric butterfly valves.
- Connection to the existing infrastructure
- Provision of soil erosion measures by means of gabions and mattresses.

### C3.1.3 NATURE OF WORKS

The scope of work for this project includes, among others, the following activities:

- a) Site establishment and removal of site establishment
- b) Accommodation of traffic
- c) Site clearance
- d) Excavation to expose existing continuously welded steel pipelines, cutting into pipelines and recovery of pipes. Demolition of existing reinforced concrete chambers and recovery of valves and fittings.
- e) Earthworks for Pipe Trenches
- f) Soil erosion protection and mitigation measures



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Witness 2



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- g) Supply and installation of new 800 mm Ø and 600 mm Ø potable water pipelines including:
  - i) Supply and delivery of steel pipes, valves, fittings and other pipe appurtenances
  - ii) Placing, joining, and testing of pipes and specials
  - iii) Pipe bedding
  - iv) Construction of valve chambers for isolating, air and scour valves, offtakes
  - v) Connection to the existing infrastructure
  - vi) Installation of cathodic protection features
- h) Minor structural civil works at the site of Olifantspoort WTW to raise concrete walls and replacement of filter media
- i) Refurbishment and replacement of the mechanical and electrical components including chemical dosing systems, and the Control & Instrumentation system of the Olifantspoort WTW
- j) OH&S
- k) Shutdown coordination with the engineers and the LNW
- l) Environmental Management
- m) Community Liaison and stakeholder management

#### **C3.1.4 DELIVERY OF MATERIALS AND EQUIPMENT**

It is the responsibility of the Contractor to take delivery, off-load, store and move into their permanent position all equipment and materials covered under this contract.

The Contractor shall, at its own expense, be responsible for the delivery to the Site of imported plant and equipment, materials and Contractor's plant and equipment in connection with the execution of the *works*, including but not limited to securing of permits and customs clearances, and payment of handling costs, storage costs, releasing costs, transportation costs, and duties, taxes, imposts, excise and charges of any kind that may be imposed by the South African Government, or any of its agencies and political subdivisions relating to the supply and delivery to the Site of the imported plant and equipment, materials and Contractor's plant and equipment.



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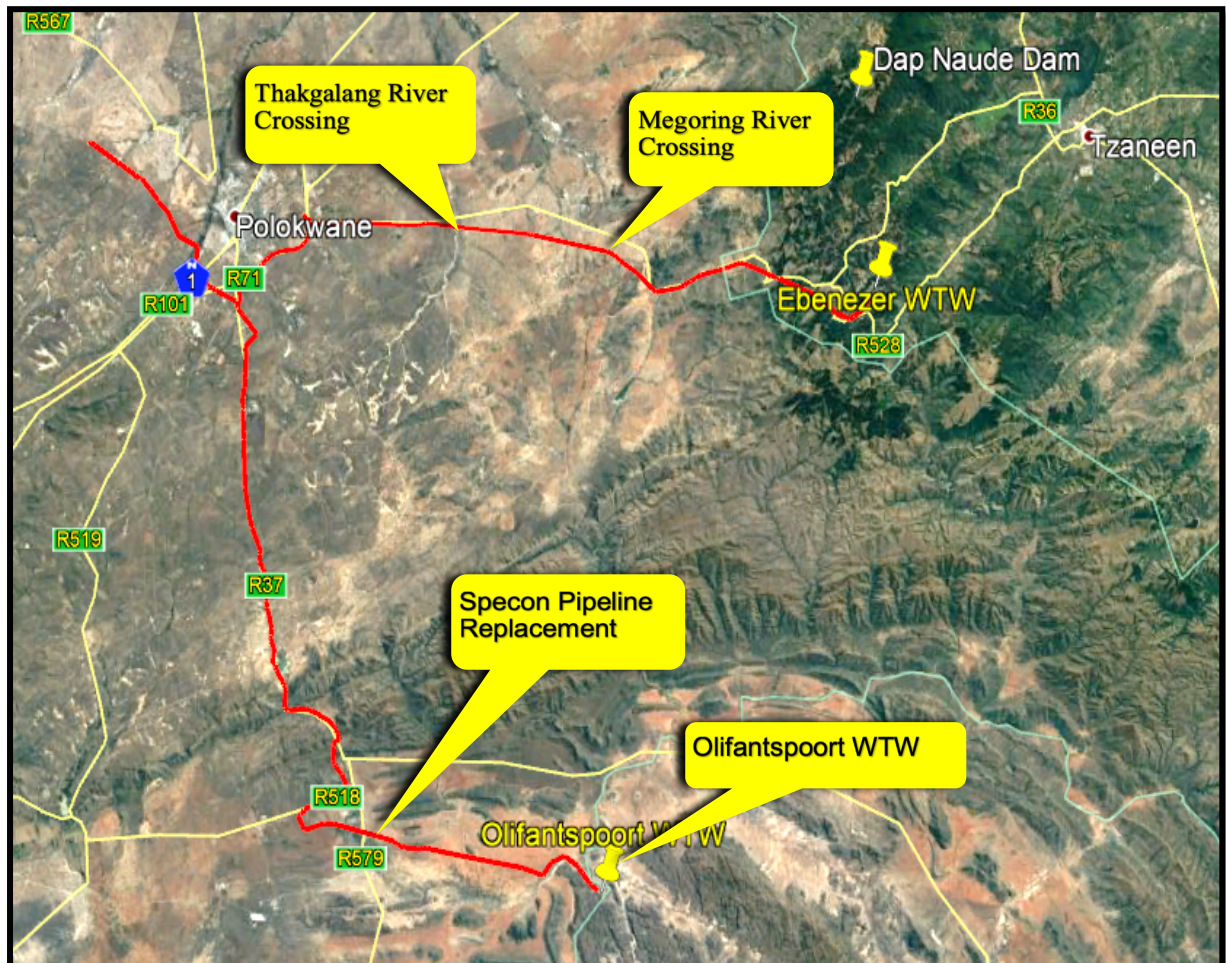
Witness 1



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### C3.1.5 LOCATION AND ACCESS TO THE WORKS

The project area covers Polokwane Local Municipality and Lepelle-Nkumpi Local Municipality as



indicated on the Figure below.

#### C3.1.5.1 SPECON PIPELINE REPLACEMENT PHASE 3

This project is located in Lepelle-Nkumpi Local Municipality, starting at chamber OL46, on the existing 800 mm ND pumping main from the Olifantspoort WTW, (with the coordinates 29°34'0.94"E, 24°19'0.55"S), and terminating at the inlet to the Specon Reservoirs (29°30'37.19"E, 24°18'15.38"S).

#### C3.1.5.2 REFURBISHMENT OF THE OLIFANTSPOORT WATER TREATMENT WORKS

The site is Olifantspoort WTW is accessible from R37 road to Mashishini, on R37 immediately after crossing Chuene Pass drive approximately 2.5 km then turn right to R518 towards Lebowakgomo leading Mamaolo Village in Lepelle-Nkumpi Local Municipality with co-ordinates: 29°45'30.80"E 24°21'19.43"S.



Contractor



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Employer



Witness 1



Witness 2

### **C3.1.5.3 REHABILITATION OF MEGORING AND THAKGALANG RIVER CROSSINGS**

The two pipelines run parallel to the 600 mm ND raw water gravity main (owned and operated by PLM) from Dam Naude Dam to Polokwane LM WTW. The river crossings are located at the following co-ordinates:

- Megoring River crossing: 29°44'51.45"E, 23°54'58.49"S
- Thakgalang River Crossing: 29°37'54.52"E, 23°54'4.90"S

### **C3.1.6 TEMPORARY WORKS**

Bidders shall allow for all the temporary works they will require for the execution of the works in the scheduled items in the BOQ. No separate payments will be made for temporary works.

### **C3.1.7 CONTRACTOR'S CAMP SITE AND SECURITY**

The Contractor shall make his/her own arrangements regarding the establishment of a campsite and housing for his/her construction personnel and all regulations stipulated by the local authority shall be adhered to. The contractor shall be responsible for the security of his/her personnel and construction plant on and around the site of the works and for the security of his/her camp. Bidders shall allow for the establishment and maintaining the Contractor's camp and for security under the appropriate scheduled items and the employer will consider no additional claims in this regard.

### **C3.1.8 POWER, WATER SUPPLY AND OTHER SERVICES**

The contractor shall make his own arrangements concerning the supply of electrical power and all other services. No direct payment will be made for the provision of electrical and other services. The cost of providing these services will be deemed included in the rates and amounts tendered for the various items of work for which these services are required.

The employer does not guarantee supply of power and the Contractor shall make arrangements for his/her own emergency supply to his/her camp and critical machinery required for the continued Contractor's operations. No extension of time due to lack of electrical power shall be entertained.

The Contractor should note that all electrical installations shall be undertaken by a qualified electrician and should be so dully approved by the approving authority in the location at which temporary power is installed.

The Contractor shall make his/her own arrangements for the supply of potable water for his/her site camp and for the execution of the works. No direct payment shall be made for the provision of water for the Contractor's site camp or for construction, and it will be deemed that the rates for these services are included in the amounts tendered for the various items of work for which these services are required.

### **C3.1.9 PROGRAMME REQUIREMENTS FOR CONSTRUCTION ACTIVITIES**

The Contractor shall programme his/her activities to be suitable in terms of his/her resources to complete the Contract inside the stipulated Contract period.

### **C3.1.10 ACCOMMODATION OF TRAFFIC**

The Contractor may not commence construction activities before adequate provision has been made to accommodate traffic in accordance with the requirements of this document and the South African Road Traffic Signs Manual.



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The Contractor shall submit proposals in connection with directional signs to the Engineer for approval prior to commencement of the works.

### **C3.1.11 CONSTRUCTION IN CONFINED AREAS**

It may be necessary for the Contractor to work in confined areas. The method of construction in these confined areas depends on the contractor's construction plant. However, the Contractor must note that measurement and payment will be in accordance with the specified cross-sections and dimensions, irrespective of the method used to achieve these cross-sections and dimensions, and that the rates and amounts tendered will be deemed to include full compensation for any special equipment or construction methods or for any difficulty encountered in working in confined areas and narrow widths, and at or around obstructions, and that no extra payment will be made nor will any claim for payment be considered on account of these difficulties.

### **C3.1.12 BARRICADING OF EXCAVATIONS**

All excavations in close proximity to pedestrian and vehicular traffic are to be barricaded to the satisfaction of the Engineer. Barricading shall consist of a minimum of two strands of parallel and horizontal wire of at least 2mm gauge, the topmost strand being fixed at least 1m above ground level. These wires shall be fixed to the approved fence posts, which shall be securely fixed in a vertical position.

The visibility of these barricades shall be enhanced by the attachment of high visibility construction tape to the posts and wire strands and by the placing of reflective signing to the Engineer's satisfaction. All costs arising from these requirements are to be included in the tendered rates for excavation.

### **C3.1.13 CONTINUITY OF WATER SUPPLY**

The existing infrastructure which will be refurbished or rehabilitated is crucial for potable bulk water supply to Polokwane City and communities along the trunk pipelines and it is therefore crucial that they should be kept in operation during the construction period. The installation of bypass pipelines is critical to achieve this requirement and the following shutdown criteria is applicable:

- The pipelines can be shut down for a maximum period of 48 hours to allow for the connection of the bypasses to the existing pipelines and new replacement pipelines.
- The Contractor shall give at least two weeks' notice for the impending shutdown to the Engineer. Approval for the shutdown shall be granted by the Engineer after consultation with the Employer and all affected stakeholders.
- The Contractor shall continually monitor the activities during the shutdown period to ensure that all connections and repair works are carried out within the prescribed period. No additional payment shall be made for this supervision and the rate shall be deemed to have been included in the rates for the applicable works to be carried out.

### **C3.1.14 HEALTH AND SANITATION**

The Contractor shall provide health and sanitation in accordance to the latest Health and Safety Act regulations. In a similar manner change rooms, shower facilities, site personnel eating facilities with gender separation where required are to be supplied. The Contractor shall be responsible for the safe and environmentally acceptable disposal of all rubbish and rubble from the site, accumulated during the construction period. All facilities must comply with the OHS Act.

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Chemical toilets will only be allowed on a temporary basis for use at the furthest areas of the works, or areas remote of the site camp, provided for one per 10 labourers of the Contractor's staff with separate facilities for male and female staff.

The Contractor shall make arrangements for the proper maintenance of these facilities.

Reference is made to the Health and Safety Act and specific requirements for sanitation.

The Health and Safety requirements are to be the prevailing standards requirements.

The main camp of the Contractor will be expected to have container type ablution facilities with combined shower and hand wash facilities. Each chemical facility must be equipped with a hand cleaning facility with soap and paper towel dispenser. All effluent to be collected in containers for disposal of and evacuated timeously off site. Upon appointment and within two weeks a detailed plan must be put in place and submitted for approval by the Occupational Health and Safety Agent.

The Contractor shall be responsible for disposal of refuse and waste generated by his staff on a daily basis. The site is to be kept clean, neat and tidy, to the Employer's satisfaction

### **C3.1.15 NOTICE OF COVERING OF WORKS**

The Contractor shall give due notice to the Engineer, whenever any work is intended to be covered over with earth or otherwise, in order that the Engineer may examine the work to determine that it is in accordance with the Specification and that its correct dimensions may be ascertained before the work is covered, and in default of such notice being received the work shall be uncovered at the Contractor's expense whenever instructions are given by the Engineer to do so.

### **C3.1.16 INSPECTION AND REJECTION OF FAULTY/SUB-STANDARD WORK**

The Engineer or his/her representative (Resident Engineer) appointed by the Engineer shall have the full power to inspect the work during every stage of its construction, and for that purpose shall have free access to the works at all times. Should any work appear to the Engineer, or his representative not be executed in accordance with the Specifications, the same may be immediately rejected, and the Contractor shall forthwith carry out the making good, breaking down and rebuilding where applicable of rejected work at the Contractor's own expense.

The Engineer or his/her representative (Resident Engineer) appointed by the Engineer shall not be used as the Contractor's Site Agent. The Contractor is deemed to have carried out all process control before asking for the work to be inspected.

The inspection of all welds will be on all stages of construction and no joints will be accepted for completion unless they have been inspected and approved by an independent welding inspector who will be appointed by the Engineer on behalf of the Employer. The acceptance or rejection and instruction to rectify the works issued by the welding inspector shall be deemed to have been issued by the Engineer and the Contractor shall duly execute such instruction.

The inspection of all concrete works will be done at all stages of construction and no works will be certified or accepted without the written acceptance of the works by the Engineer or his/her representative (Resident Engineer) appointed by the Engineer. Setting, formwork, steel fixing and casting of concrete shall be the responsibility of the Contractor and shall each be inspected and accepted by the Engineer or his/her agent before the Contractor can proceed to the next stage.

All inspection call outs (successful or not) will be recorded and must be reported at the site meetings.

Both parties must agree all defect lists with a completion date entered into the list for each defect.



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All site communications are to be confirmed in writing:

### **C3.1.17 SETTING OUT OF THE WORKS**

The Contractor shall set out the works using the various Setting out Drawings. The Contractor shall establish a system of setting out and reference pegs encased in concrete, which will be checked by the Surveyor of the Engineer and then maintained and protected for the duration of the contract by the Contractor. Should any benchmark be disturbed it will be re-established and verified by the Engineer's Surveyor at the cost of the Contractor.

The Contractor shall set out the Works relative to the afore-mentioned system of reference pegs in accordance with the positioning and dimensions on the drawings.

### **C3.1.18 DISINFECTION OF THE WORKS**

The Contractor shall be responsible for the cleaning out and disinfection of the temporary and permanent Works before the Engineer can accept such Works for payment. The Contractor shall disinfect the Works in accordance with SANS 1200L.

### **C3.1.19 CONTROL OF STORM WATER INGRESS AND SUBSURFACE WATER**

The Contractor shall be fully responsible for the control of stormwater ingress into the temporary or permanent works as well as handling of groundwater seepage into the works. No separate payment will be made in this regard and the cost of controlling storm water ingress and control of groundwater seepage shall be deemed included in the tendered rates.

### **C3.1.20 FINISHING AND TIDYING**

Under no circumstances will spoil, rubble, materials, equipment or unfinished operations be allowed to accumulate unnecessarily. In the event of this occurring, the Engineer will have the right to withhold payment for as long as necessary in respect of the relevant works in the area(s) concerned.

### **C3.1.21 CONTRACTOR'S CODE OF CONDUCT**

#### **C3.1.21.1 WORKMEN INSTANT DISMISSAL**

Workers may be instantly dismissed for the following:

- Theft
- Violence with co-workers or supervising staff; and
- Committing a criminal offence and is sentenced to prison without an option of a fine.

#### **C3.1.21.2 MISCONDUCT**

Any employee who, within a period of six months, receives two written warnings and the third time is guilty of misconduct as listed below may be dismissed without further notice:

- Insubordination and constant refusal to follow instructions.
- Absenteeism for three or more days without a valid medical certificate.
- Repeatedly coming to work late.
- Disruptive behaviour conducive to delays in the work programme.
- Intimidation of other workers.
- Dangerous behaviour.
- Use of alcohol or drugs during working hours.

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- Non-performance.
- Abuse or waste of company property or resources.
- Continuous absenteeism.

### **C3.1.22 FEATURES REQUIRING SPECIAL ATTENTION**

#### **C3.1.22.1 EXISTING SERVICES**

The Contractor shall be deemed to have made allowance in his/her tender for the need to protect the existing services from damage and to hand over the completed works with the existing services intact and undamaged.

Notwithstanding the information given herein, the Contractor shall retain full responsibility for establishing the exact positions of the various existing services, which may not be shown on the construction drawings, in advance of the main construction work.

The use of specialised equipment for location of power cables and other services is allowed into the relevant Bill of quantities.

All the works areas with known services are to be preceded with thorough investigation with hand excavations and exposure of the services.

The employer does not have as-built drawings indicating the extents of the depths of the existing pipeline to be recovered. The Contractor shall remain responsible for any damage caused to the existing pipeline as a result of construction works, and shall exercise caution in areas where the Contractor will excavate by machine.

#### **PLEASE NOTE:**

Most of the work will be conducted in the proximity of the existing live pipelines, which are in a poor condition. These pipelines supply the bulk of potable water to Polokwane and surrounding areas. Therefore, the Contractor needs to ensure that the method for the hard rock excavations do not compromise the integrity of the existing infrastructure, which is already prone to frequent failures.

The above implies that use of explosives for hard rock excavation needs to be strictly controlled and might not be permitted, which would require alternative methods for the excavation of new pipeline trenches.

#### **C3.1.22.2 SURVEY BEACONS**

The Contractor's attention is drawn to SABS 1200 A, Clause 5.1.2 - Preservation and Replacement of Beacons and Pegs subject to the Land Survey Act - and to the liabilities of the Employer and the Contractor in this regard. Attention in this regard is drawn to Sections 35(1) and (2) of the Land Survey Act of 1927 which lays down the penalties applicable to those who are responsible for interfering with permanent survey beacons, bench marks, reference marks or trigonometric stations.

Before commencing operations, the Contractor shall locate and mark all survey pegs and beacons and shall immediately submit a written report in duplicate of any missing or damaged pegs and beacons to the Engineer's Representative, who shall verify the facts and return a countersigned copy of the report to the Contractor.

The Contractor shall be held responsible for the maintenance of all the cadastral and benchmark pegs on the site that are recorded as existing at the commencement of construction, and for the placement of any pegs that are found to be missing or disturbed upon the completion of the contract. A Completion Certificate shall only be issued after the Contractor has handed back all the pegs and



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has submitted a certificate from a registered Land Surveyor to the Engineer stating that all relevant pegs are in their correct positions.

Notwithstanding Clause 8.8.5 of SABS 1200 A, the Contractor shall tender sums for searching for and protecting all pegs. Where pegs have been moved, disturbed or covered on the specific instruction of the Engineer, such pegs shall be reinstated by a registered Land Surveyor and shall be paid for by number reinstated on instruction of the Engineer.

### **C3.1.23 WORKING NEAR AND DAMAGE TO EXISTING SERVICES AND WORKS**

#### **C3.1.23.1 RESPONSIBILITY OF THE CONTRACTOR**

The position of the known existing services is indicated on the layout drawings according to the most recent information available. Irrespective, the Contractor shall take note that sections of the proposed pipeline are adjoined and crossed by many services, which might have not been captured on the construction drawings.

Therefore, the Contractor must make provision for suitable means of locating and accommodating all the services, including those not known or shown on the drawings and shall always exercise the due precautions to identify and accommodate the existing services. Should the Contractor find evidence of possible buried services, he shall notify the Engineer immediately thereof. The Engineer will assess the situation and instruct the Contractor on an appropriate course of action to be taken.

Furthermore, the Contractor shall bear the cost of the repair of damage to any service of which the possible existence could reasonably have been ascertained by him in good time.

All the work will be carried out in the vicinity of existing services and all such services shall remain in operation at all times, except where arrangements have been made with the Engineer and LNW for the interruption of the services for the purposes of carrying out the Works under this Contract.

The Contractor shall be responsible for checking the locations of all services and to ensure that no damage is caused by construction operations.

In order to enable any changes that might be needed in the design of the pipelines to be made timeously, before starting any excavations or where indicated in the scope of work or site information that underground services either cross or are located adjacent to the Works that are to be constructed, such services shall be exposed by hand ahead of trenching operations. Care shall be taken in exposing such services to avoid damaging them. An item has been allowed for in the Bill of Quantities for hand excavation or other methods to search for existing services.

All cables and pipes shall be considered "live" unless confirmed otherwise by the relevant service authority.

The Contractor shall be allowed to use non-intrusive equipment for the location of existing services if so agreed. Should excavation be required to identify and or expose any services this shall be for the account of the contractor and shall only proceed once the relevant permits or approvals have been issued by the Employer.

The Contractor shall be responsible for any damage to existing services and existing works in the execution of this contract and shall reimburse the Owner concerned for any repairs required or compensation for damages awarded. The Contractor's attention is drawn to Clause 5.4 of SABS 1200A.

#### **C3.1.23.2 NOTIFICATION**

The Contractor will be responsible for immediately notifying the Authorities concerned, the Employer and the Engineer regarding any damage caused to public services and existing works.



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Employer



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The Engineer's Representative must be notified immediately.

### **C3.1.24 WORK ON PUBLIC AND PRIVATE PROPERTY**

The Contractor shall exercise the greatest care to avoid unnecessary damage to trees, gardens, fences, walls and structures on public and private property, and also strictly supervise the behaviour of his/her workmen.

On completion of the work over or in the vicinity of Local or Tribal Authority or private property, the Contractor shall ensure that anything that may have been disturbed or damaged has been compensated for or reinstated to a condition equal to that which it was before construction commenced and to the satisfaction of the owner concerned. The materials resulting from any demolition of existing structures shall be the property of the owner.

The Contractor will be required to inspect all properties within 50m radius of any excavation on site before and after completion of the works. A detailed written and photographic record of the inspections to be submitted to the Engineer and Client.

### **C3.1.25 PERMITS AND WAYLEAVES**

The Employer will make the arrangements for all security access permits and wayleaves necessary within the Works.

All interfaces with existing works are indicated in the relevant drawings. The Contractor shall take note of these and make appropriate allowances for dealing with and where necessary making modifications (or tying-in to) these services.

### **C3.1.26 REGULATIONS**

The Contractor shall in all respects conform to the requirements contained in any relevant regulations by higher authorities.

The Contractor shall pay and indemnify the Employer against any fees or charges by law and shall keep the Employer and the Engineer indemnified against all penalties and liabilities of any kind for breach by the Contractor or any of the conditions due by law, except insofar as amended or specifically allowed by the Engineer.

### **C3.1.27 ENVIRONMENT AND SAFETY**

The Contractor shall comply with all the requirements laid down in the Environmental Management Plan (EMP). The Contractor shall take time to acquaint his/her employees with the provisions, regulations, duties, obligations and prohibitions, and shall accept sole liability for due compliance with the duties, obligations and prohibitions and absolve the Employer from being obliged to comply with the aforesaid duties, obligations and prohibitions.

In case of failure on the part of the Contractor to comply with the requirements of the EMP, the Employer shall be entitled to employ and pay other persons to carry out any remedial work to rectify any consequence resulting from the non-compliance by the Contractor and all cost consequent or incidental thereto shall be borne by the Contractor and shall be recoverable from the Contractor by the Employer. If it is not practical to rectify any consequence, resulting from the non-compliance of the Contractor with the EMP the Employer will be entitled to impose a penalty on the Contractor, which penalty shall be in relation to the expense that the Contractor would have incurred to comply.

The Contractor shall indemnify the Employer and the Engineer against responsibility for damage to the environment on the site of the Works.

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### C3.1.28 BLASTING INDEMNITY

The Contractor may require to blast rock from time to time during the implementation of construction works. The use of a certified Blasting Contractor as sub-contractor is paramount to the safety of the surrounding public, person and property. When blasting in the close proximity of fixed structures, the Contractor shall take full responsibility for any costs related to damage thereof.

It is in this context that it is recommended for the Contractor to fully photograph and record structural damage, prior to blasting. The Contractor shall complete the "Blasting Indemnity Form T2.4.3.4" included in Document 1 of the Contract, before the commencement of the Works.

The Contractor is responsible for compliance with all requirements of the authorities concerned with respect to the safety of the Works, labourers and the public during blasting activities. Any negligence or non-compliance on the side of the Contractor shall be sufficient cause for the Employer's Agent to suspend the Works and the Contractor shall have no claim for additional compensation against the Employer in such an event.

### C3.1.29 RECORDING OF WEATHER

The Engineer shall adjudge the extent of the delays that are attributable to "abnormal climatic conditions", however, in order to assist the Engineer in this regard, the Contractor must erect a rain gauge at the site office to record rainfall figures. The reading of the rain gauge shall be made at 08h00 and 16h00 of each day of the contract. The records shall be submitted weekly to the Employer's Agent (the Engineer); together with a statement recording the Contractor's opinion of the effect on the Contractor's programme of any weather condition that the Contractor may consider to be abnormal.

## C3.2 ENGINEERING DESIGN

### C3.2.1 Design services

- a) The Employer is responsible for the design of the permanent Works as reflected in these Contract Documents unless otherwise stated.
- b) The **Contractor** is responsible for the design of the temporary Works and their compatibility with the permanent Works.
- c) The **Contractor** shall supply all details necessary to assist the engineer in the compilation of the as-built drawings.

### C3.2.2 Employer's design

The design of the Works is detailed on the technical specifications and the drawings (see C3.2.5 below) and described in this document.

### C3.2.3 Design brief

The Contractor will not be responsible for any design for the permanent works, unless where it is explicitly indicated otherwise. However, the Contractor will be responsible for shop detail drawing prior to manufacturing of all mechanical, electrical and control & instrumentation equipment. The Contractor will also be required to submit detailed method statements for all aspects of both permanent and temporary works. These shall include

- Site establishment
- Setting out of the works



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- Bulk and restricted excavations
- All civil works
- Building work
- Pipe laying, jointing and testing

### C3.2.4 Design procedure

The Contractor shall submit his drawings prior to the start of manufacture, as required by the Engineer. All such material shall become the property of the Employer.

All fabrication and installation shall only be to the approved drawings.

All correspondence and submittals shall be prominently identified as relating to the works and shall be submitted under the cover of appropriate letters or transmittal notes in accordance with the correspondence procedures which will be advised by the Engineer after the signing of the Contract. All documentation supplied by the Contractor to the Engineer in hard copy shall also be supplied in electronic format.

The Engineer shall have the right at all reasonable times to inspect at the works of the Contractor or Sub-contractors, or elsewhere, and all drawings of any portion of the works.

Drawings shall bear accepted Contract references using a project title block which will be supplied by the Engineer. Also detailed revision blocks and drawing numbers shall be suffixed accordingly.

### C3.2.5 Drawings

The drawings issued to Tenderers as part of the tender documents must be regarded as provisional and preliminary for the Tenderer's benefit to generally assess the scope of work. The drawings are issued separately to this document contained in **Volume 2**.

The work shall be carried out in accordance with the latest available revision of the drawings approved for construction.

At commencement of the contract, the Engineer shall deliver to the Contractor copies of the construction drawings and any instructions required for the commencement of the works. From time to time thereafter during the progress of the works, the Engineer may issue further drawings or revisions for construction purposes as may be necessary for adequate construction, completion and defects correction of the Works.

The Contractor is required to supply to the Engineer for the records of the Employer all the relevant information in order allow the Engineer to compile "As Built" record drawings, which will be submitted to the Employer after completion of the construction. Any information in the possession of the contractor, which the Engineer requires to complete the as-built drawings, shall be supplied to the Engineer before a certificate of completion will be issued. No additional payment will be made and the cost related thereto shall be deemed included in the tendered rates for the related items.

#### C3.2.5.1 LIST OF DRAWINGS FOR SPECON PIPELINE REPLACEMENT PHASE 3

| Drawing Number       | Description                      |
|----------------------|----------------------------------|
| P1001-OL1EM-CIV-0001 | List of Drawings                 |
| P1001-OL1EM-CIV-0100 | Locality Plan and Project Layout |



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| Drawing Number               | Description                                     |
|------------------------------|-------------------------------------------------|
| <b>Water Layouts</b>         |                                                 |
| P1001-OL1EM-CIV-1001         | Overall Layout and Longitudinal Section         |
| P1001-OL1EM-CIV-1002         | Layout and Longitudinal Section CH 0,000 to 704 |
| P1001-OL1EM-CIV-1003         | Layout and Longitudinal Section CH 704 to 1409  |
| P1001-OL1EM-CIV-1004         | Layout and Longitudinal Section CH 1409 to 2113 |
| P1001-OL1EM-CIV-1005         | Layout and Longitudinal Section CH 2113 to 2818 |
| P1001-OL1EM-CIV-1006         | Layout and Longitudinal Section CH 2818 to 3523 |
| P1001-OL1EM-CIV-1007         | Layout and Longitudinal Section CH 3523 to 4228 |
| P1001-OL1EM-CIV-1008         | Layout and Longitudinal Section CH 4228 to 4932 |
| P1001-OL1EM-CIV-1009         | Layout and Longitudinal Section CH 493 to 5637  |
| P1001-OL1EM-CIV-1010         | Layout and Longitudinal Section CH 5637 to 6342 |
| P1001-OL1EM-CIV-1011         | Layout and Longitudinal Section CH 6342 to 6942 |
| P1001-OL1EM-CIV-1012         | List of Coordinates                             |
| P1001-OL1EM-CIV-1013         | Road and River Crossings Layout                 |
| <b>Pipe Jacking Drawings</b> |                                                 |
| P1001-OL1EM-CIV-1100         | Pipe Jacking Layout and Cross Section           |
| P1001-OL1EM-CIV-1101         | Pipe Jacking Detail                             |
| <b>Water Details</b>         |                                                 |
| P1001-OL1EM-CIV-1301         | Air and Isolation Valve Details                 |
| P1001-OL1EM-CIV-1302         | Scour Valve Details Type A                      |
| P1001-OL1EM-CIV-1303         | Scour Valve Details Type B Sheet 1              |
| P1001-OL1EM-CIV-1304         | Scour Valve Details Type B Sheet 2              |
| P1001-OL1EM-CIV-1305         | Scour Valve Details Type C Sheet 1              |
| P1001-OL1EM-CIV-1306         | Scour Valve Details Type C Sheet 2              |
| P1001-OL1EM-CIV-1307         | Isolation Valve Details                         |
| P1001-OL1EM-CIV-1308         | Connection 1 Layout and Details                 |
| P1001-OL1EM-CIV-1309         | Connection 2 Layout and Details                 |
| P1001-OL1EM-CIV-1310         | Non-return Valve Details                        |



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| Drawing Number               | Description                                       |
|------------------------------|---------------------------------------------------|
| P1001-OL1EM-CIV-1311         | Non-return Valve Details Schedule of Items        |
| <b>Water Typical Details</b> |                                                   |
| P1001-OL1F-CIV-1401          | Information Board                                 |
| P1001-OL1F-CIV-1402          | Pipe Marker Detail                                |
| <b>Civil Typical Details</b> |                                                   |
| P1001-OL1EM-CIV-1501         | Typical River Crossing Detail                     |
| P1001-OL1EM-CIV-1502         | Typical Road Crossing Detail                      |
| P1001-OL1EM-CIV-1503         | Flexible Bedding Detail                           |
| <b>Structural Details</b>    |                                                   |
| P1001-OL1EM-CIV-3221         | Structural Details for Air Valves                 |
| P1001-OL1EM-CIV-3222         | Structural Details for Scour Valve Details Type A |
| P1001-OL1EM-CIV-3223         | Structural Details for Scour Valve Details Type B |
| P1001-OL1EM-CIV-3224         | Structural Details for Scour Valve Details Type C |
| P1001-OL1EM-CIV-3225         | Structural Details for Isolation Valves           |
| P1001-OL1EM-CIV-3226         | Structural Details for Cat ladder and Platforms   |

#### C3.2.5.2 LIST OF DRAWINGS FOR REFURBISHMENT OF THE OLIFANTSPOORT WATER TREATMENT WORKS

| Drawing Number      | Description                     |
|---------------------|---------------------------------|
| P1001-OL1C-CIV-0001 | List of Drawings                |
| P1001-OL1C-CIV-0101 | Layout of the Olifantspoort WTW |
| P1001-OL1C-CIV-0401 | Details of Raising of Walls     |

#### C3.2.5.3 LIST OF DRAWINGS FOR REHABILITATION OF MEGORING AND THAKGALANG RIVER CROSSINGS

| Drawing Number       | Description                                                                                          |
|----------------------|------------------------------------------------------------------------------------------------------|
| P1001-EB1L-CIV-0001  | List of Drawings                                                                                     |
| P1001-EB1L-CIV-1000  | River Crossings Rehabilitation Locality Plan                                                         |
| <b>Water Layouts</b> |                                                                                                      |
| P1001-EB1L-CIV-1001  | Pipeline Replacement and Rehabilitation at Thakgalang River crossing Layout and Longitudinal Section |



Contractor



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|                           |                                                                                                       |
|---------------------------|-------------------------------------------------------------------------------------------------------|
| P1001-EB1L-CIV-1002       | Pipeline Replacement and Rehabilitation at Megoring River crossing<br>Layout and Longitudinal Section |
| <b>Water Details</b>      |                                                                                                       |
| P1001-EB1L-CIV-1301       | Typical Bypass Detail                                                                                 |
| P1001-EB1L-CIV-1302       | Single Pipe Bedding and Concrete Encasement Details                                                   |
| P1001-EB1L-CIV-1303       | Air Valve Chamber Detail                                                                              |
| P1001-EB1L-CIV-1304       | Scour Valve Chamber Detail                                                                            |
| <b>Structural Details</b> |                                                                                                       |
| P1001-EB1L-CIV-3201       | Air Valve Chamber Structural Detail                                                                   |
| P1001-EB1L-CIV-3202       | Scour Valve Chamber Structural Detail                                                                 |
| P1001-EB1L-CIV-3203       | Structural Details for Catladders and Valve Supports                                                  |

#### C3.2.5.4 CUSTODY OF DRAWINGS AND SPECIFICATIONS

The Drawings and Specifications shall remain the sole property of the Employer and the Contractor shall be required to sign for receipt thereof. The copyright of all documents shall vest in the Employer and the Drawings and Specifications may not be reproduced, in part or in whole, without the written authority of the Employer, either directly or through an authorized agent of the employer.

#### C3.2.5.5 COPYRIGHT

The copyright in all documents, drawings and records related to the purpose and scope of the Works or related in any other manner to the Works, shall vest in the Employer and the Contractor shall not furnish any information in connection with the Works to anybody without the approval of the Employer.

#### C3.2.5.6 EQUIVALENCY OF STANDARDS AND CODES

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract.

Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval.

Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least seven days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.



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Employer



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## C3.5 PROJECT MANAGEMENT

### C3.5.1 MANAGEMENT OF WORKS

#### C3.5.1.1 APPLICABLE SANS 1921 STANDARDS

The following SANS 1921 Construction and Management requirements for works standards and associated specification data are applicable:

- SANS 1921-1 General engineering and construction works
- SANS 1921-2 Accommodation of traffic
- SANS 1921-5 Earthworks activities performed by hand
- SANS 1921-6 HIV/AIDS awareness

The specification data applicable to the SANS 1921-1 standards mentioned above are as follows:

| Clause                | Specification Data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Essential Data</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4.1.7                 | The requirement for drawings, information and calculations for which the Contractor is responsible is detailed in the project specifications. (See "design procedure" etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4.2.1                 | The responsibility strategy assigned to the Contractor for the works is A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4.3                   | The planning, programme and method statements are to comply with the following: <ul style="list-style-type: none"> <li>1) Programme is to show critical path activities and to include design, procurement, construction, test and commissioning stages.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4.4                   | The Contractor will be solely responsible for the production of work that complies with the Specifications to the satisfaction of the Engineer. To this end it will be the full responsibility of the Contractor to institute an appropriate Quality Assurance (QA) system on site. The Engineer will audit the Contractor's quality assurance system on a regular basis to verify that adequate independent checks and tests are being carried out and to ensure that the Contractor's own control is sufficient to identify any possible quality problems which could cause a delay or failure.<br><br>The Contractor shall ensure that efficient supervisory staff, the required transport, instruments, equipment and tools are available to control the quality of his own workmanship in accordance with his QA-system. His attention is drawn to the fact that it is not the duty of the Engineer or the Engineer's representative to act as foreman or surveyor. |
| 4.12.2                | The samples of materials, workmanship and finishes that the Contractor is to provide and deliver to the Employer are: <ul style="list-style-type: none"> <li>1) Bedding material from commercial source</li> <li>2) Aggregate for concrete mix design</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4.12.2                | The fabrication drawings that the Contractor is to provide and deliver to the Employer are: <ul style="list-style-type: none"> <li>1) As required.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



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Employer



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| Clause            | Specification Data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.14.3            | The office accommodation, equipment, accommodation for site meetings and other facilities for use by the employer and his agents shall consists of a suitable room for the monthly site meetings able to accommodate 15 members from the Employer/Engineer and site staff.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4.14.5            | Toilet facilities need to be made available for the sole use of the employer and his agents.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 4.14.6            | The requirements for the provision and erection of sign boards are:<br>1) As per SANS 1200 AB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4.17.3            | Services which are known to exist near the site are:<br>1) Overhead telephone line and electricity lines<br>2) Buried electricity cable<br>3) Water pipelines (including large diameter, high pressure pipelines)<br>4) Roads, Freeway<br>5) Cable ducts<br>6) Sewers<br><p>The positions of some of the known underground services have not been shown on the drawings as these will not be affected by the Works. The Contractor will thus not be required to contact service owners and ascertain the locations and status of services.</p> <p>The Contractor is required to dig by hand a pilot trench to identify possible services where in doubt. If services are found the Engineer must be notified immediately so that a decision can be made regarding relocation or protection.</p> |
| 4.17.4            | The requirements for detection apparatus are: As required by the Contractor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 4.17.7            | Existing services, which are damaged by the Contractor, shall be repaired and all costs of the repair shall be borne by the Contractor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4.18              | The additional health and safety requirements of the <i>Employer</i> are as specified in the health and safety specification included in the Particular Specifications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4.22              | The works identified suitable for allocation to selected sub-contractors or local community endeavours:<br>1) Brickwork<br>2) Reinforcing tying<br>3) Paving<br>4) Clearing & landscaping<br>5) Backfilling and compaction<br>6) Fencing<br><p>Please note that the list above is for unskilled ad semi-skilled local commercial concerns, however more skilled local commercial concerns are available and the renderer to endeavour to utilise these as far as possible.</p>                                                                                                                                                                                                                                                                                                                  |
| <b>Variations</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 4.1.1 (o)         | Record drawings to be provided electronically and as specified in the Scope of Work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



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Witness 2



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| Clause | Specification Data                                                  |
|--------|---------------------------------------------------------------------|
| 4.1.10 | Where reference is made to "SANS 2001", substitute with "SANS 1200" |

| Additional Clauses |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.6 (e)            | The Contractor is to ensure that stormwater runoff or groundwater seepages are controlled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4.7.4              | No blasting will be permitted within 10 m of any structure, pipeline or service unless the Contractor can satisfy the Engineer that his proposed blasting methods and controls are such that no damage will be caused to the adjoining structure, pipeline or service. The Contractor will provide for vibro-recordings to be taken at no additional cost to the Employer.                                                                                                                                                                                                                                                                                                         |
| 4.9.5              | It will be necessary for the Contractor to liaise closely with the LNW management and Engineer's Representative regarding any disruption of the water supply as a result of his construction activities.<br>The Contractor shall advise all parties in writing at least 1 month in advance of any such operation, the time for which the supply will be disrupted and the area that will be affected. Disruption of water supplies to any area shall not exceed forty-eight (48) hours in duration. It is recommended that connections to existing pipework be undertaken during weekends/after hours as agreed with the service owner when the water consumption is at a minimum. |
| 4.9.6              | The provision of security for the Contractor's site establishment, plant and personnel is the sole responsibility of the Contractor and no claims for payment for additional security measures taken during the duration of the contract will be entertained.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4.17.8             | The Contractor shall so carry out all his operations as not to encroach on, or interfere with, trespass on, or damage adjoining land, buildings, properties, road structures, pipelines, places and things, near the Works.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

#### C3.5.1.2 PLANNING AND PROGRAMMING

##### The Contractor shall ensure that:

- They is well informed with regard to the Employer's overall implementation programme for construction and investigative projects and makes available resources as required to efficiently complete required services
- They compiles designs, documentation, reports and drawings timeously as not to unnecessarily delay the implementation of the construction or investigative projects.
- The programme shall at minimum contain the following:
  - Time Scale (minimum): Days, where the project period does not exceed three months. Weeks, where the project period exceeds three months.
  - Time Scale (maximum): Months, where the project period does not exceed one year. Years, where the project period exceeds one year.
  - Tasks: All construction tasks and activities shall be shown. 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 project shall be grouped. Resources allocation and task



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dependency shall be indicated.

- g) Multiple Project Programming: Where multiple projects are part of the same Contract documentation, the Contractor shall provide a programme per project. However, where interdependency exists the programmes shall be integrated, but divided on the highest level per project followed subsequently by further divisions per phase or stage.
- h) Start and Finish Dates: All tasks shall have specific start and finish dates.
- i) Critical Path: All tasks forming the programme line that will establish any delays in the overall project period shall be clearly indicated and an indication of their sensitivity characteristics shall be provided.
- j) Progress Tracking: The Contractor shall be required to periodically (at minimum of a monthly basis) indicating the project progress per task graphically and on a percentage basis.
- k) Non-working Time: All South African public holidays, weekends and the local traditional annual builder's break (as identified in the contract data) shall be incorporated in the programme.

**The Contractor's Programme shall include:**

- a) Dates for submission (by the Contractor) of designs and or design documents.
- b) Dates for ordering of special and/or long delivery items.
- c) Dates for issue of or approval of drawings for planning purposes.
- d) Dates for issue of or approval of drawings for manufacture and construction purposes requiring the approval of the Engineer.
- e) Dates for the placement of orders for material, receipt of material, fabrication and manufacture, works (factory) testing, shipment, erection and commissioning.
- f) Dates showing start and completion of site construction of each section and each major component of the permanent works.
- g) Dates showing the delivery of all built-in steelwork, anchor bolts, etc.
- h) Dates for start and completion of Engineering Design (including allowances for review/approval by the Engineer).
- i) Dates for submittal and acceptance of drawings.
- j) Dates for submittal of operation and maintenance manuals.
- k) Dates for submittal of commissioning check lists and detailed commissioning schedules for acceptance (3 months before the commencement of commissioning).
- l) Dates for submittal of commissioning check lists and detailed schedules of approval (3 months before the commencement of commissioning).
- m) Dates for submission of complete schedules for all manufactured items.
- n) Dates for Test on Completion as defined in the Contract Data.

Activities shall be timed in week units except for commissioning or similar detailed programmes, which shall have activities, specified in days. Activities on which it is intended to operate multiple shift working shall be clearly defined.

Method and resources statements are required for all critical items to prove that the period allocated to them fits the overall programme and that the Contractor's plant and labour are consistent with the time allowed. Critical items shall include (as a minimum) all reinforced, structural steelwork, pipework, tie-ins to existing services and specialist work.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall update and revise the Programme once a week or when required by the Engineer. The submission to and acceptance by the Engineer of such updated and revised Programme, shall not relieve the Contractor of any of his duties or responsibilities under the Contract and existing laws.

#### **C3.5.1.3 SOFTWARE APPLICATION FOR PROGRAMMING**

Only the “**Microsoft Project**” software package will be accepted.

The Contractor shall make the programme available in MS Project format and in print version. The Contractor shall also ensure that all necessary hardware and software in this regard are available at all times on site and that at least one member of the permanent site staff is competent on their operation.

#### **C3.5.1.4 SEQUENCE OF THE WORKS**

Whenever work being done by other Contractors is contiguous or related to the Works included in this Contract, the sequence of handling the *Works* shall be such that the least delay possible will result to each Contractor and such sequence may be determined by the Engineer. The Engineer will establish the respective rights of the various interests involved in order to secure the completion of the various portions of the Works in general harmony.

The Contractor shall be responsible for the co-ordination and proper execution of the Works, including co-ordination with other Contractors and organizations to the extent specified in the Contract Documents. The Contractor shall, as specified in the Contract Documents, afford all reasonable opportunities for carrying out their work to:

- a) any other Contractors employed by the Employer,
- b) the staff and workmen of the Employer, and
- c) the staff and workmen of any legally constituted public authorities who may be employed in the execution on or near the site of any work not included in the Contract, which the Employer may require.

The Contractor shall obtain, co-ordinate and submit to the Engineer for his information all details (including details of work to be carried out off the Site) from Sub-contractors. The Contractor shall be responsible for the locations of their work or materials, in order to ensure that there is no conflict with the work of other Sub-contractors, the Contractor or other Contractors.

The Contractor shall give the works the constant attention necessary to facilitate the progress thereof and shall cooperate with the Engineer and other Contractors in every way possible.

#### **C3.5.1.5 METHODS AND PROCEDURES**

##### **C3.5.1.5.1 Monthly Reports**

The Contractor shall prepare and submit to the Engineer within 15 days after the first day of every month a written progress report together with a monthly progress schedule summarising the progress of the various sections of the work both at the place of manufacture and at site. Three (3) copies of the monthly progress report shall be submitted in accordance with the correspondence procedures.

Such progress reports shall indicate accurately the status of different activities covering design, material procurement, manufacture, works (factory) tests, shipping, erection, testing and commissioning and shall be related to key dates identified in the programmes referred to in the *conditions of contract*.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



The report shall also include data on labour strength and equipment employed. The programme submitted with the monthly report shall show cumulative progress towards scheduled completion, expressed as a percentage, of all items shown in the contract schedule.

The reports shall indicate the degree of criticality on each section of the Work, together with the slippage or impending slippage on any key event and shall be directly related to the contract schedule and supporting detail programmes for sections of work.

The monthly progress report shall be in the format acceptable to the Engineer and written in the English language and shall include:

- a) Photographs and detailed descriptions of progress, including each stage of design (if applicable), procurement, manufacture, delivery to the Site, construction, erection, testing and commissioning.
- b) Charts showing the status of construction documents, drawings, purchase orders, manufacture and construction.
- c) For the manufacture of each main item of plant and materials, the name of manufacturer, manufacture location, percentage progress, and the actual or expected dates of commencement of manufacture, Contractor's inspections, tests and delivery.
- d) Records of personnel and Contractor's equipment on the Site.
- e) Copies of quality assurance documents, test results and certificates of materials.
- f) Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and
- g) Comparisons of actual and planned progress, with details of any aspects which may jeopardize the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome such aspects.
- h) Financial status of Contract.

#### **C3.5.1.5.2 Weekly Reports**

The Contractor's Site Manager shall prepare a weekly summary report covering all the site activities and submit it to the Engineer. This report shall include projected work activities for at least 2 weeks ahead of those being reported upon. In addition, this report shall include a weekly site labour return giving imported and local labour and each Sub-Contractor's labour, broken down into trades. Full details of site labour disputes (or off site disputes affecting the Contract) shall be reported to the Engineer immediately. The weekly statement shall give details of all construction plant machinery, offices and materials. The Contractor shall submit three (3) copies of weekly report to the Engineer which shall include.

- a) Summary of progress.
- b) Potential problems and proposed solutions.
- c) Project schedule update.
- d) Project permit status.
- e) Construction photographs.
- f) Status of orders and procurement.
- g) Drawing list.
- h) Plant test schedule.
- i) Construction schedule (critical path method, S-curve).



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall submit to the Engineer a weekly return detailing the numbers of the various classes of workmen employed by him on the Site, the plant and Contractor's equipment on the Site or on order and any other information that may reasonably be required.

#### **C3.5.1.5.3 Detailed programme and progress reports**

Detailed monitoring of the progress of the Contract by the Contractor is to be achieved by the use of critical path network planning and review techniques.

Following approval of the Programme, the Contractor shall submit within thirty (30) days, detailed programmes for all work to be executed during the Contract. These programmes, which shall embrace design, supply, manufacture and site construction shall be based on the Contract Programme and be used as target programmes and may be subject to revision. Further detailed programmes for progressive stages of the Contract shall be prepared by the Contractor as required by the Engineer.

The Contractor shall, whenever required by the Engineer, also provide in writing for his information a general description and drawing or sketch of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works.

The Contractor shall plan in detail his section of the work by the use of bar charts to record progress of the design, manufacturing and delivery elements and by the use of the critical path network procedure for work on site. The issue and approval of drawings shall be covered in detail by the use of appropriate check points in the detailed programme, including in particular design information interface events with others. The manufacturing work shall be broken down into check points in the detailed programme. The manufacturing work shall be broken down into sufficient detail for the information supplied to relate correctly to the erection detailed programme on which the activity durations shall not exceed four weeks. Activities shall cover all aspects for which the Contractor or his Sub-contractors are responsible and also indicate site access, points at which terminals and access will be available to or required from others and services required from the Employer.

The Contractor shall ensure that the resources required to meet these programmes are available to him and his Sub-contractors. A table shall be prepared indicating the expected level of each type of resource for the duration of the site work.

The detailed programmes must be analysed by the Contractor, either manually or by computer, and three copies of the following tabulations presented:

- a) A schedule tabulated in order of increasing total float showing for each activity:
  - (i) event numbers,
  - (ii) brief description of activity and responsibility,
  - (iii) duration,
  - (iv) early and late starting and finishing dates,
  - (v) total float.
- b) A schedule tabulated in order of early start date by total float for eight weeks ahead of the 'update' date. The information given in this schedule shall be the same as that indicated above.

All programmes and progress reports shall be provided by the Contractor in a form acceptable to the Engineer. Full access shall be made available to the Engineer to visit the Contractor's and Sub-contractor's works to verify the status of design and manufacture.

Other requirements in respect of programmes are given in the Conditions of Contract.

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Contractor

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Employer

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Witness 2

#### **C3.5.1.5.4 Progress Meetings**

The Contractor will be required to attend regular formal construction progress meetings with the Engineer during manufacture and on site. The site meetings will also involve the other Contractors so that the progress of construction both on this Contract and the entire Project may be reviewed. Such meetings may be monthly and may require the up-dating of the Contractor's Contract and detailed Programmes, in which case three copies of the up-dated programme shall be submitted to the Engineer within 7 days of the agreed up-dating.

The Contractor shall also attend informal weekly meetings with the Engineer on site and provide a weekly estimate of the work anticipated on each work section.

The updated programme, if necessary, after reconciliation and incorporation of changes, shall become the new basis for further execution of the Works without any modification of the Contract's completion date. The updating of the programme shall not give rise either to any extension of time or to any entitlement for any additional payment.

#### **C3.5.1.5.5 Interface Meetings**

The Contractor shall hold regular interface meetings with all other contractors who may be performing work on behalf of the Employer and with representatives of the Employer involved with the activities related to or in the vicinity of the works to be performed under this Contract. The purpose of the interface meetings shall be to ensure that the work the Contractor is performing on the project is efficiently and effectively co-ordinated without duplication or miscommunication and that there is full compatibility between sections that are designed and constructed by the various contractors.

#### **C3.5.1.6 QUALITY PLANS AND CONTROL**

##### **C3.5.1.6.1 General**

The Contractor shall have a well-organized Quality Management System (QMS) based on ISO 9001 Series) to assure that items and services, including subcontracted items and services, comply with the Works Information.

This clause specifies the minimum requirements necessary to ensure that proper attention is given to the materials used, the standard of workmanship, the manufacturing and construction processes, and the quality of all components.

The Contractor shall include in all his orders to Sub-contractors a note stating that materials and plant covered are subject to inspection by the Engineer.

##### **C3.5.1.6.2 Quality Control and Assurance System**

All design, manufacturing, processing, testing and inspection operations affecting the plant or material shall be governed by Quality Assurance procedures in accordance with the directives of the ISO 9001 standards while the production and installation shall be governed by quality assurance procedure in accordance with the directives of the ISO 9002 standards or equivalent. These may be subject to surveillance by the Engineer.

A tentative QMS procedures shall be submitted together with the tender and shall meet the requirements stated in the Design Procedure. Within thirty (30) days of the Commencement Date, the Contractor shall submit six (6) copies of his complete quality control and assurance procedures, manuals for review and acceptance by the Engineer.

The manual shall include pro-forma checklists for all requirements of the Contractor's quality control and assurance program and those called for in the Works Information.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Quality Control and Assurance System to be submitted shall include but not necessarily be limited to the following:

- a) Programme requirements for materials and plant procurement and manufacture with description of design control, purchased material control, quality verification tools, manufacturing control, materials and components selection, handling and packaging, etc.
- b) Programme requirements for plant production with detailed description of Quality Assurance organization of the Contractor, Quality Assurance Functions and Procedures and Performance Monitoring.
- c) Quality Assurance Programme Tests with detailed description of the test procedures to be conducted.

In addition to the requirements of these ISO Standards or their equivalents the Contractor shall:

- a) Establish procedures for adequate planning and resourcing of all quality related activities including the preparation of quality plans.
- b) Establish measures for the identification and control of items throughout all stages of the Contract. This shall include measures to maintain traceability as identified in agreed quality plans.
- c) Arrange for the protection of quality of the product to include delivery to the specified destination.
- d) Control their measuring and test equipment in accordance with established procedures for measurements and calibration systems and ensure that such equipment that may be used by Sub-contractors to verify work is similarly controlled.

Where any site installation and/or test and commissioning work is involved, the Contractor shall prepare contract specific quality assurance procedures in agreement with the Engineer prior to commencements of such works.

The Contractor shall be responsible for specifying the quality assurance requirements to his Sub-contractors, for approving Sub-Contractors quality assurance programme and for ensuring compliance with the requirements.

The Contractor shall ensure that all appropriate technical information is extracted from the Contract documents and specifications and passed on to the Sub-contractors.

The Contractor shall ensure that all computer systems and software to be utilized on the project is qualified for the application under consideration and such qualification is documented.

#### **C3.5.1.6.3 Quality Management Audit**

The Contractor shall carry out periodic assessments of the adherence to the Quality Plan and Quality Control Plans by senior qualified staff who are not normally employed on the Site. The Engineer and/or his representative shall be invited to attend at the periodic assessments meeting and be afforded the opportunity to report on the implementation of the Quality System at the Site. The assessment reports shall be copied to the Engineer.

#### **C3.5.1.6.4 Corrective Actions**

The Contractor's quality assurance programme shall provide for prompt detection and correction of all events and conditions adversely affecting quality, including failures, malfunctions, incidents, trends, deficiencies, deviations, non-conformances, and defective materials.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The Contractor shall establish and maintain methods for verifying and determining the cause of an adverse condition and for initiating necessary improvement and corrections to preclude repetition. Quality trends shall be analysed to furnish a basis for improvement in work performance. The Contractor's corrective action system shall extend to the performance of other participating Contractors and Sub-contractors when necessary and shall provide for the interchange of corrective action information. Identification of the adverse condition, its cause, and the corrective action taken shall be recorded and reported to appropriate levels of management.

The Contractor shall establish and implement procedures for reporting, verifying, analysing, and correcting failures, including those that occur during development and qualification testing. The procedure shall provide assurance that the cause and mode of each failure are determined that the potential safety and availability implication is evaluated, and that corrective action is taken.

A failure report shall be prepared to identify the failed item and its origin or source of manufacture and shall describe the failure, the test status at time of failure, and the probable cause and mode of failure, and recommended corrective action.

Failure to conform to the specified requirements will result in the issuing by the Engineer of a Corrective Action Request. Failure to rectify the deficiencies covered by a Corrective Action Request within the period stated will result in the Engineer invoking the provisions of GCC.

#### **C3.5.1.6.5 Design revision and substitution of Material**

Any revision affecting the design and manufacturing of the Works, or any substitution of materials that is deemed necessary shall be notified by the Contractor to the Engineer for the latter's review and approval.

#### **C3.5.1.6.6 Contractor's responsibility**

Acceptance by the Engineer of the Contractor's quality assurance programme, quality plans and inspection and test plans, or of those of his Sub-contractors will not relieve the Contractor of his obligation to provide goods and services which meet the requirements of the Contract.

#### **C3.5.1.7 ENVIRONMENT**

The Contractor shall strictly comply with the requirements of the EMP issued for this Works. He shall be liable for any damages/destruction to the environment including penalties that will be imposed by the relevant government agency arising from non-compliance of the requirements of EMP occasioned in any manner by his acts or neglect, or his agents, employees, or workmen in the execution of the works.

#### **C3.5.1.8 ACCOMMODATION OF TRAFFIC ON PUBLIC ROADS OCCUPIED BY THE CONTRACTOR**

The Contractor shall draft a traffic accommodation plan and submit to the Engineer prior to commencement of work on any road. The approval by the Engineer shall not relieve the Contractor of any of his responsibilities or obligation.

#### **C3.5.1.9 OTHER CONTRACTORS ON SITE**

The Contractor needs to take note that other contractors may also be working on the same site and allow therefore in his planning/work scheduling.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

#### **C3.5.1.10 TESTING, COMPLETION, COMMISSIONING AND CORRECTION OF DEFECTS**

The Contractor shall be responsible for conducting all testing as described herein. Work under this section shall include all labour, materials, and support services required to completely test all hardware and software. If a type of equipment does not meet the specifications or requirements as stated in these Specifications or the System Design Document, it shall be the Contractor's responsibility to correct the problem in all units of that equipment furnished, at no additional cost to the Employer.

All of the components, sub-systems, interfaces and systems processes constituting the works shall be tested individually and together to demonstrate that they meet the contract requirements and provide a system that functions in accordance with the contract.

The Contractor shall be responsible for the performance of all of the tests described below to satisfy the objectives of each testing phase as determined by the Engineer. The Employer shall have the right to witness any and all tests. Test plans shall be submitted to the Engineer a minimum twenty-one (21) days prior to the planned start of testing. Testing shall not commence until the plans have been approved.

Unless otherwise specified, all test plans shall include at a minimum the following:

- a) Overview of test including test objectives
- b) Pass/fail criteria
- c) Traceability matrix listing of all requirements and specifications from the Contract that are included/to be verified in the test and their cross-reference to the Specifications and System Design Document.
- d) Test setup and test measuring equipment (including descriptive diagrams)
- e) Listing of tools, test applications, simulators, etc. required to perform the test
- f) Entry/start-up conditions
- g) Exit/closing conditions
- h) Test procedures and scripts to be executed
- i) Test recording form
- j) Test comments form
- k) Signatures and verification form

The Employer reserves the right to direct at no additional cost, the following changes to the test plans:

- a) The addition of procedural changes and other reasonable tests to reasonably assure System performance and conformance;
- b) Investigation into any apparent troubles or anomalies with respect to the System;
- c) An audit of all test reports and verification of any or all previous tests and Measurements.

The Contractor shall provide written notification of readiness to test for all required test stages a minimum of two (2) weeks in advance of the testing.

Upon successful completion of any test, the Contractor shall prepare and submit within two (2) weeks a report summarizing the results with relevant test records appended. All such test reports will be reviewed by the Engineer.

The Contractor shall develop and maintain a standard set of regression tests for each device or subsystem. Regression tests shall be run for any affected device or subsystem in the event that any testing is halted and restarted in accordance with the requirements of the defect resolution.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



### C3.5.1.11 TRAINING

The Contractor needs to take note that the Employer aims to use the infrastructure contracts to expose students from various institutions to construction activities as part of their training programme. Full support needs to be provided by the Contractor in this programme to obtain maximum benefits for the students allocated to the contract.

The Contractor shall be responsible to train the Employer's designated personnel according to the requirements specified herein. The Contractor shall be responsible for the supply of all training materials including, at a minimum:

- a) Training setups of equipment, including mounting and all power supplies and simulators required to simulate normal operation.
- b) Instructor guides.
- c) Student guides.
- d) Operations manuals.
- e) Training presentations.
- f) Training handouts.
- g) Quick reference guides.
- h) Interactive videos or demonstrations.
- i) Course and instructor comments sheets

A Training Program shall be developed and submitted a minimum forty-five (45) days before delivery of training materials that describes:

- a) Each course to be conducted.
- b) An overview of delivery methods for each course, including hands-on and group work experience.
- c) The course objectives for trainees.
- d) An evaluation plan, including criteria for success of the course, based upon the goals and objectives, and evaluation steps and instruments to be employed.
- e) A proposed schedule for each class, keyed to the installation process and constrained by availability of trainees away from regular duties.
- f) A plan for developing or customizing course material.
- g) Resumes of personnel proposed to be trainers for each class, demonstrating that they are experienced, effective training professionals.

Training shall include course development, providing instructors, and supplying all handouts, materials, classroom aids, etc. required to conduct the training. Training shall take place at the site facilities. Practical training on equipment shall occupy a significant portion of all training classes. The training presentations and material shall be in English.

### C3.5.1.12 RECORDING OF WEATHER

The Contractor shall be permitted to take his own rainfall measurements on site subject to the Engineer's approval, but access to the measuring gauge(s) shall be under the Engineer'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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### C3.5.1.13 INCLEMENT WEATHER

No extension of time for completion will be granted because of normal inclement weather but extension of time shall be determined for abnormal rainfall or wet conditions.

The extension request must be in accordance with the formula given below, separately for each calendar month or part thereof. It shall be calculated for the period from the Commencement Date to the Due Completion Date or the date of issue of the Certificate of Practical Completion, whichever is earlier, and excluding the Contractor's year-end recess.

$$V = (N_w - N_n) + (R_w - R_n) / X$$

The symbols shall have the following meanings:

|                |   |                                                                                                                                                                            |
|----------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V              | = | Extension of time in calendar days in respect of the calendar month under consideration;                                                                                   |
| N <sub>w</sub> | = | Actual number of days during the relevant calendar month on which Y mm or more of rainfall has been recorded;                                                              |
| N <sub>n</sub> | = | Average number of days in the relevant calendar month Y mm or more of rain has been recorded, as derived from the rainfall records provided in the Project Specifications; |
| R <sub>w</sub> | = | Actual rainfall in mm for the month under consideration                                                                                                                    |
| R <sub>n</sub> | = | Average rainfall in mm for the relevant calendar month, as derived from the rainfall records provided in the Project Specifications.                                       |

**Note:**

If "V" is negative and its absolute value exceeds N<sub>n</sub>, then V shall be taken as equal to minus N<sub>n</sub>.

For this Contract, X and Y shall have the following values:

$$X = 20 \text{ mm / d} \quad Y = 10 \text{ mm}$$

Extensions of time for part of a month shall be calculated using pro rata values of N<sub>n</sub> and R<sub>n</sub>.

The total extension of time shall be the algebraic sum of the monthly totals for the period under consideration, but if the grand total is negative, the time for completion shall not be reduced due to abnormal rainfall.

The factor (N<sub>w</sub> - N<sub>n</sub>) shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds Y mm.

The factor (R<sub>w</sub> - R<sub>n</sub>)/X shall be considered to represent a fair allowance for variations from the average in the number of days during which rainfall does not exceed Y mm but wet conditions prevented or disrupted work.

The formula does not take account of flood damage, which could cause further or concurrent delays, which shall be treated separately as far as extension of time is concerned.

The figures for N<sub>n</sub> and R<sub>n</sub> given below are the most suitable figures available and shall be used unless other are agreed at the commencement of the Contract.

The rainfall records from the nearest weather station at Polokwane, Rainfall Station

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

No. 0677802BX, for the period 1992 to 2016 are reproduced in the Table under **C4.2 – Atmospheric / Climatic data** stipulating the monthly averages ( $N_n$  and  $R_n$ ) for this period will be taken as the normal rainfall for the purposes of this Contract.

**C3.5.1.14 FORMAT OF COMMUNICATIONS**

All Contract communication shall be in English and in writing (letters, faxes and electronic mail).

**C3.5.1.15 KEY PERSONNEL**

The Contractor shall be required to allocate sufficiently experienced personnel to execute the Contract successfully.

**C3.5.1.16 MANAGEMENT MEETINGS**

The Contractor and such other persons as may be nominated by the Engineer shall be required to attend periodic site meetings, the date and place for which will be set by the Engineer in consultation with the Employer and Contractor.

A main purpose of the site meetings will be to review and discuss progress and programme, and all persons attending the site meetings must be empowered to act on behalf of the firms they represent.

**C3.5.1.17 FORMS FOR CONTRACT ADMINISTRATION**

The Contractor shall maintain a file or files (hard copy and electronically) per Contract project, which shall contain:

- a) the details of the Sub-contractors,
- b) project programme, with commencement and completion date;
- c) procurement information;
- d) progress reports, minutes, letters, faxes, emails of all project or project related correspondence;
- e) record documentation, reports, designs, and drawings;
- f) a copy of the Health and Safety Plan and the Environmental Management Plan;
- g) record of cost implications, variations, claims and disputes; and
- h) empowerment records.
- i) copy of quality (QMS) plan and all related documentation/procedures.

At the end of this Period of Performance the Contractor shall hand-over such hard copy files to the Employer, including all electronic records, documentation, reports, designs, and drawings.

**C3.5.1.18 DAILY RECORDS**

The Contractor is to provide a site diary, which is to be kept on site, for the purpose of keeping daily records in respect of work performed on the site. This shall be made available to the Engineer upon request.

**C3.5.1.19 BONDS AND GUARANTEES**

If the Tenderer, when notified of the acceptance of his tender, fails to provide a guarantee within the period stipulated in the Contract Data and the Employer elects to cancel the contract on that ground, the Employer may demand a sum of R1 000 per day, or the Employer may take other action whether by way of a claim for loss or damage suffered by the Employer arising out of such breach.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

#### **C3.5.1.20 PAYMENT CERTIFICATES**

The Contractor shall be required to complete a progress report before he will be allowed to complete the standard payment certificate required to be submitted with his tax invoice.

##### **C3.5.1.20.1 Measurement of work for payment**

All measurements for the purpose of payment shall be made by the Contractor and accepted by the Engineer. The Contractor shall be responsible for obtaining the Engineer's acceptance not later than one week after the measurements have been made.

#### **C3.5.1.21 PERMITS**

The Contractor shall acquire all permits, approvals and/or licenses from all local or national government authorities or public service undertakings in South Africa and abroad, which such authorities or undertakings require the Contractor to obtain and which are necessary for the performance of the Contract, including without limitation, visas for the Contractor's and Sub-Contractor's personnel and entry permits for all imported Contractor's plant and equipment.

#### **C3.5.1.22 LOCK-OUT PROCEDURE**

Lock-out systems consist of isolation of electrical, hydraulic, pneumatic, mechanical systems and isolating valve and pipeline systems. Where the Contractor uses his own procedure, this procedure will be forwarded to the Engineer for review prior to commencement of work.

A lock-out procedure shall be available at all electrical distribution boards. Valves isolated shall be locked and the Contractor shall be in possession of the keys. The Contractor and his employees shall be trained in accordance with this procedure and declared competent by the Contractor to lock out electrical equipment. They shall at all times adhere to the procedure's requirements.

#### **C3.5.1.23 PERMIT TO WORK**

A system shall be implemented to control identified high risk activities. The Contractor shall ensure that the proper permit is issued as agreed upon and authorised by an appointed competent person before commencing with the work.

Some of the activities that may require a permit to work within a construction or plant area are:

- a) Cold work in areas where operational plant or equipment can pose a threat
- b) Radiographic works
- c) Working in confined spaces
- d) Excavation work (cable clearance permit)
- e) Demolition work
- f) Blasting
- g) Piling
- h) Work being done within 50 m of an overhead power line
- i) Use of a hazardous substance, e.g. lead

Contractors are to ensure that all personnel who will be signing on work permits within the Site are trained in the work permit procedures and declared competent.

#### **C3.5.1.24 USE OF DOCUMENTS BY THE EMPLOYER**

All information (communications, designs, drawings, documents or reports) provided to the Employer by the Contractor, in the course of performing the service required for this Contract, are intended to ensure that the projects are implemented successfully.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

#### **C3.5.1.25 PROPERTY PROVIDED FOR THE SERVICE PROVIDER'S USE**

The Contractor shall provide all physical resources, including properties, for the successful execution of the project.

#### **C3.5.1.26 PROOF OF COMPLIANCE WITH THE LAW**

The Contractor shall ensure that he complies to all prevailing legislation that applies to the provision of his services as part of this Contract and indemnifies the Employer where he deliberately neglects compliance with such legislation.

### **C3.5.2 Health and safety**

#### **C3.5.2.1 HEALTH AND SAFETY REQUIREMENTS AND PROCEDURES**

The Contractor shall comply with the Employer's Occupational Health and Safety requirements detailed in the Contract.

In addition, the Contractor shall comply with the following requirements in respect to Health and Safety.

The Contractor shall comply with the Occupational Health and Safety Act (OHS Act No 85 of 1993) and the Construction Regulations, 2003. The "minimum safety requirements" referred to above shall be those contained in the Construction Regulations, 2003 of the OHS Act. Furthermore, the Contractor shall comply with any additional current statutory requirements of any relevant Government Departments regarding health and safety and specifically environmental health issues.

The Contractor shall establish and enforce rules to ensure the health and safety of his own employees and those of its Sub-contractors so that high standards of personnel health and safety are achieved and maintained. The Contractor shall exercise and enforce all necessary care and measures to preclude exposure of personnel, labour and nearby residents (if any) to potential health hazards and environmental pollutants. The Contractor shall, in collaboration with and to the requirements of the local health authorities, ensure that medical and first aid staff, first aid facilities, sick bay and ambulance service are available at the accommodation and on the Site at all times, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Engineer may reasonably require.

The Contractor shall appoint a member of his staff at the Site to be responsible for maintaining the safety, and protection against accidents, of personnel on the Site. This person shall be qualified for his work shall have the authority to issue instructions and take protective measures to prevent accidents. The Contractor shall send in additional to the legislated parties, to the Engineer, details of any accident as soon as possible after its occurrence.

Except for the Employer's risks, as defined in the conditions of contract, the Contractor is solely responsible for the safety, protection, and security of his personnel, third persons, the works, Plant, installations, and the like. Accordingly, the Contractor shall comply faithfully with any and all pertinent South African laws, decrees, regulations and ordinances, and shall take all necessary safeguards to prevent occurrences of accidents, loss or damage of any kind during the execution of the works. He shall provide, erect, and maintain all necessary and suitable barricades and sufficient warning lights, danger signals and other signs and shall take all necessary precautions for the protection of the works and the safety of his personnel and the public.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### C3.5.2.2 Contractor's Health and Safety System

The Contractor shall submit to the Engineer its Health and Safety Management System documentation for acceptance, and shall implement its system prior to the start of the construction.

The Health and Safety Management System shall cover but not be limited to the following:

- a) Skills and qualifications required by employees.
- b) Training and supervision of employees.
- c) Auditing of and reporting on health and safety practices and performance.
- d) Reporting and investigation of incidents.
- e) Identification and removal of hazards.
- f) Provision and use of protective equipment and clothing.
- g) Proper use and care of tools and equipment.
- h) Informing employees and Sub-contractors of health and safety hazards they may be exposed to, including hazards that may be created by other Contractors.
- i) Development and implementation of emergency procedures.
- j) Development and implementation of maintenance isolation systems and procedures to ensure the safety of personnel while working on plant which could be energized, activated or made hazardous by other means.
- k) Provision of access zones for employees which are appropriately designated (e.g. "hard hat area", "out of bounds", "ear protection must be worn", "eye protection must be worn").
- l) Provision of safety engineers and provision of suitably qualified first aiders.
- m) Provision of first aid facilities equipped to a standard sufficient to cope with minor injuries and provide care and comfort before treatment by professional medical staff for more serious cases.

### C3.5.2.3 SAFETY OFFICER

The Contractor shall formally appoint a suitably qualified member of his staff to be responsible for safety aspects of the work on site and shall ensure compliance with all safety requirements. Particular attention shall be given by the Contractor to such aspects as risk assessment for individual tasks, lighting, handrails and especially around dangerous openings, access stairs, toeplates and general cleanliness. Regular safety meetings will be held. The Contractor shall take appropriate action immediately following any instructions which the Engineer may make concerning matters of safety. The relevant OH&S procedures and specification developed for the project shall be strictly adhered to during execution of Works forming part of the project. The specifications and procedures form part of this tender document. The work under this contract is defined as "Construction Work" and regulated under the Occupational Health and Safety Act, 1993 (latest amendment) and the Contractor shall adhere to all the legislative requirements as per Construction Regulations 2003.

The Contractor shall provide for the cost of the health and safety measures in the Bill of Quantities.

The Contractor shall notify the Provincial Director in writing of the construction activities before work commences, if required.

The Site representative shall be present on site during working hours and any orders or instructions, which the Engineer may give to the Site Representative, shall be deemed to have been given to the Contractor.

The Contractor shall develop and demonstrate to the Engineer a suitable and sufficiently documented Health and Safety plan based on the safety specification.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



The Contractor shall if called upon to do so, submit a preliminary Health and Safety Plan, failing to do so may lead to the disqualification of this tender.

#### **C3.5.2.4 RISK MANAGEMENT**

The Contractor ensures that his risks are managed to enable the successful execution of the project.

The Contractor's risk that occurs or develops during construction is brought to the Employer's attention in writing immediately. A risk register must be kept for the duration of the project.

A general risk analyses is performed prior to starting with the construction work, which must form part of the Safety Plan. All work will be carried out in conformance to the Occupational Health and Safety Act, 1993 (latest amendment) and the Contractor shall adhere to all the legislative requirements as per Construction Regulations 2003.

#### **C3.5.2.5 EMPLOYER'S HEALTH AND SAFETY SPECIFICATION**

The Contractor shall comply with the following conditions:

- a) The Contractor shall appoint and notify the Engineer in writing, a competent Site representative, with the duty of supervising the construction work.
- b) The Contractor shall appoint, and notify the Engineer in writing, a competent person to perform a risk assessment before construction work commences, during construction work and which shall form part of the Health and Safety Plan.
- c) The Contractor shall appoint and notify the Engineer in writing, a competent person responsible for the preparation of a fall protection plan, amending, maintaining and adherence thereto.
- d) The Contractor shall execute the necessary steps to prevent uncontrolled collapse of new or existing structures and no part shall be loaded in a manner that would render it unsafe.
- e) The Contractor shall appoint and notify the Engineer in writing, a competent person responsible that all formwork and support work structures are adequately designed, erected, supported, braced and maintained.
- f) The Contractor shall appoint and notify the Engineer in writing, a separate competent person with relevant experience for each of the operations whose first duty will be to, and who shall, supervise all stages in the operation. The operations are:
  - i. Excavation, blasting and trimming of the excavations, backfilling and formation of embankments.
  - ii. Pipe jacking operations.
  - iii. Supply of concrete aggregates and the batching, mixing, transporting, placing, compacting and curing of concrete.
  - iv. Loading, unloading, transport and installation of steel pipes including areas where pipe jacking has occurred.
  - v. Cutting and welding of steel pipes.
  - vi. Installation of valves, dirt boxes and water meters.
- g) All scaffolding shall comply with the Occupational Health and Safety Act 1993 (latest amendment).
- h) The Contractor shall appoint and notify the Engineer in writing, a competent person responsible for suspended platform and that all erectors, operators and inspectors are competent to carry out their work.
- i) Every material hoist and its tower shall be constructed of sound material in accordance to the Construction Regulations 2003 (latest amendments).



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- j) All explosive power tools shall comply to and be in accordance to Construction Regulations 2003 (latest amendment).
- k) Notwithstanding the provisions of the Driven Machinery Regulations (Government Notice No R533, latest amendment), the Contractor shall ensure that work is carried out in a safe manner where tower cranes are used.
- l) The Contractor shall ensure that all construction vehicles and mobile plant are maintained, operated and used in a safe manner by competent operators.
- m) Notwithstanding the provision of the Electrical Installations Regulations (Government Notice R2920 latest amendment) and the Electrical Machinery Regulations, (Government Notice R1953 latest amendment), the Contractor shall take the necessary steps to provide a safe environment for construction work to proceed.
- n) Notwithstanding the provisions for the use and storage of flammable liquids as determined in the General Safety Regulations (Government Notice No R1031, latest amendment), flammable liquids shall be stored in such a manner to prevent fires and explosions.
- o) The Contractor shall provide lifejackets for workers where construction work is done near or over water.
- p) Notwithstanding the provisions of the Environment Regulations for Workplaces (Government Notice No R2281, latest amendment), implement and maintain suitable housekeeping.
- q) Notwithstanding the provisions for the stacking of articles in the General Safety Regulations (Government Notice R1031, latest amendment) the Contractor shall appoint a competent person in writing, responsible for supervising all stacking and storage on site.
- r) Subject to the provisions of the Environment regulations for Workplaces (Government Notice No R2281, latest amendment), the Contractor shall take appropriate measures to avoid risk of fire.
- s) Notwithstanding the provisions of the Facilities Regulations (Government Notice No R1593, latest amendment), the Contractor shall provide clean and maintained facilities as required.
- t) The Contractor shall take all reasonable steps to ensure co-operation between all Sub-contractors to enable each Sub-contractor to comply with provisions of the Act.

### C3.5.3 Environmental Management

The Contractor shall take full responsibility for protecting the natural environment and eliminating or minimising the negative impacts of construction on the environment during construction. Nothing specified herein shall relieve the Contractor of any obligations or responsibilities in this regard.

The Contractor shall implement an Environmental Policy, in line with various statutory regulations, the Environmental Management Plan (EMP) and the Works information. The Policy shall be submitted to the Engineer within 28 days after the Starting Date. Upon the Engineer's acceptance, the Contractor shall immediately implement the policy and any amendments, and keep it in operation for the full duration of the contract.

The Employer's EMP is included.

The Contractor shall keep the policy updated in accordance with his Quality Management Procedures and make amendments as required by the Engineer and the circumstances prevailing at the time. The Contractor shall immediately supply the Engineer with two copies of an updated Environmental Policy which shall clearly indicate the revisions undertaken.

The Contractor shall prepare and submit the following waste management plans to the Engineer at least three months before the scheduled start-up dates of the respective systems.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

## C3.6 SPECIFICATIONS

### C3.6.1 STANDARD SPECIFICATIONS

The standard specifications on which this contract is based are the South African Bureau of Standards Standardised Specifications for Civil Engineering Construction SANS 1200. Although not bound in nor issued with this Document, the following Sections of the Standardised Specifications of SABS 1200 shall form part of this Contract:

The applicable "Standard Specifications" shall be "**Standardized Specifications for Civil Engineering Construction, Series 1200-1986**", issued by the South African Bureau of Standards (SANS 1200).

The standardised specifications (SANS 1200) must be read in conjunction with the relevant new SANS 1921 family of standards (refer to **C3.5.1.1**). In case of any discrepancy or conflict between the two, the SANS specification shall take precedence and shall govern. Refer also to the Preface on interim situation until full suite of SANS Series of Specifications is available, on the first page of the Project Specification.

The term "**Project Specifications**" appearing in any of the SANS 1200 standardised specifications is deemed to be equivalent to the term "scope of work" in SANS Specifications. The Contractor shall be in possession of these Standardized Specifications and their related SANS 0120 Code of Practice that apply equally and shall keep a copy of each on site for reference by him and the Engineer for the duration of the Contract and shall bear all expenses in this regard.

For "Workmen's Compensation Act" read "Compensation for Occupational Injuries and Diseases Act, 1993 (Act No.130 of 1993)" wherever it appears. For "Machinery and Occupational Safety Act" and "Mines and Works Act" read "Occupational Health and Safety Act, 1993 (Act 85 of 1993)" wherever they appear.

The SANS 1200 Specifications applicable to this Contract are listed under below. The variations and additions to the Standardised Specifications as well as the Particular Specifications listed above are included as **C3.6.2** and **C3.6.3**. The variations, are prefixed PS, and take precedence over the SANS Standardised Specification.

- |                  |                              |
|------------------|------------------------------|
| a) SANS 1200 A:  | General (as applicable)      |
| b) SANS 1200 AA: | General (Small Works)        |
| c) SANS 1200 AB: | Engineer's Office            |
| d) SANS 1200 C:  | Site Clearance               |
| e) SANS 1200 DA: | Earthworks (Small Works)     |
| f) SANS 1200 DB: | Earthworks (Pipe Trenches)   |
| g) SANS 1200 DM: | Earthworks (Roads, Subgrade) |
| h) SANS 1200 GA: | Concrete (Small Works)       |
| i) SANS 1200 L:  | Medium Pressure Pipelines    |
| j) SANS 1200 LB: | Bedding (Pipes)              |
| k) SANS 1200 LG: | Pipe Jacking                 |
| l) SANS 1200 M:  | Roads (General)              |

Contractor

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Witness 2

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## C3.6.2 VARIATIONS AND ADDITIONS TO THE STANDARD SPECIFICATIONS

### INDEX

|      |                            |
|------|----------------------------|
| PSA  | General                    |
| PSAB | Engineer's Office          |
| PSC  | Site Clearance             |
| PSDA | Earthworks (Small Works)   |
| PSDB | Earthworks (Pipe Trenches) |
| PSL  | Medium Pressure Pipelines  |
| PSLB | Bedding (Pipes)            |

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## PSA: GENERAL

(Applicable to SANS 1200 A - 1988 as amended 1990)

### PSA 1 SCOPE

*REPLACE THE CONTENTS OF SUBCLAUSE 1.1, INCLUDING THE NOTES, WITH THE FOLLOWING:*

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

### PSA 2 INTERPRETATIONS

#### PSA 2.3 DEFINITIONS

*IN THE OPENING PHRASE BETWEEN THE WORDS "specification" AND "the following", INSERT THE WORDS "the definitions given in the Conditions of Contract and".*

- (a) General

*ADD THE FOLLOWING DEFINITIONS:*

" 'General Conditions' and 'Conditions of Contract': The General Conditions of Contract specified for use with this Contract, together with the Contract Data (GCC 2015) as applicable.

'Specified': As specified in the Standardized Specifications, the Drawings or the Project Specifications. 'Specifications' shall have the corresponding meaning."

- (c) Measurement and payment

*REPLACE THE DEFINITIONS FOR "Fixed charge", "Time-related charge" AND "Value-related charge" WITH THE FOLLOWING:*

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

'Time-related charge': A charge, the amount of which varies in accordance with the Time for Completion of the Works, adjusted in accordance with the provisions of the Contract.

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

### PSA 3 MATERIALS

#### PSA 3.1 QUALITY

*ADD THE FOLLOWING AT THE END OF SUBCLAUSE 3.1:*

"All manufactured materials supplied shall be new materials unless the contrary is specified. All materials specified to be in accordance with SANS Specifications shall bear the SANS mark, where such a mark is available for the type of product."



Contractor



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Witness 2



Employer



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Witness 2

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## **PSA 4 PLANT**

### **PSA 4.1 SILENCING OF PLANT**

*REPLACE THE CONTENTS OF SUBCLAUSE 4.1 WITH THE FOLLOWING:*

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

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

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

### **PSA 4.2 CONTRACTOR'S OFFICES, STORES AND SERVICES**

*ADD THE FOLLOWING PARAGRAPH BEFORE THE EXISTING FIRST PARAGRAPH IN SUBCLAUSE 4.2:*

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

*DELETE "and first-aid services" IN THE SECOND PARAGRAPH OF SUBCLAUSE 4.2 AND ADD THE FOLLOWING:*

"The Contractor shall provide on the Site and in close proximity to the actual locations where the work is being executed, one toilet per 10 workmen, which toilets shall be effectively screened from public view and their use enforced. Such toilets shall be relocated from time to time as the location of the work being executed changes, so as to ensure that easy access to the toilets is maintained.

The Contractor shall, where applicable, make all necessary arrangements and pay for the removal of night soil."

*ADD THE FOLLOWING SUBCLAUSES:*

#### **"PSA 4.2.1 Contractor's Camp**

The Contractor's camp shall be kept clean at all times during construction and conform to the requirements and regulations of the Employer, authorities and the applicable Environmental Management Plan.

The Contractor must fence off his construction camp area with 1.8m high diamond mesh fence. All temporary fencing must be removed on completion of the Contract.

The camp may be used for the working hours activities of the Contractor's and the Employer's personnel and for all related facilities required by the Contractor and the Employer such as workshops, stores, testing laboratories, etc. The Contractor's personnel, including bona fide night watchmen, may only sleep within the camp should the Contractor:

- Take all the necessary steps required to comply fully with public legislation and regulations and all specification clauses governing the environment, health, transport, safety and public disturbance impacts of such on-site accommodation;
- Acquire the written permission of the Employer and relevant authority and comply with their requirements.

Should at any stage of the Contract the Employer and/or the Engineer is of the opinion that the

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Contractor

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housing of personnel within the camp site of the Contractor is causing disturbance or inconvenience to the nearby residents, then the authority granted by this clause for the Contractor to house personnel on site may be withdrawn, either partially or entirely.

The Contractor shall at all times conform to all requirements contained in law or bylaws, as well as any other requirements set by the controlling local authority.

The Contractor shall water all access roads to the construction camp, as well as working areas used by vehicles inside the camps, twice daily including weekends as required or as may be directed by the Engineer, to prevent dust being churned up by vehicles or wind.

At the completion of the construction work, the Contractor must break down and remove all concrete slabs, etc. in the construction camps and at the batching plant (if applicable), remove all rubble from the camp site and hand back the sites in a clean and tidy condition.

No Completion Certificate shall be issued for the Works unless the site clearing is done to the satisfaction of the Engineer.

#### **PSA 4.2.2 Housing**

The Contractor will not be permitted to house any personnel within his camp site unless the Employer approves a written request to this end by the Contractor.

### **PSA 5 CONSTRUCTION**

#### **PSA 5.1 SURVEY**

##### **PSA 5.1.2 Preservation and replacement of survey beacons and pegs subject to the Land Survey Act**

*DELETE THE WORDS "in the vicinity of boundaries" IN THE SECOND SENTENCE OF SUBCLAUSE 5.1.2 AND REPLACE THE WORDS "under the direction of" IN THE SAME SENTENCE WITH "in consultation and liaison with".*

*ADD THE FOLLOWING AFTER THE SECOND SENTENCE OF SUBCLAUSE 5.1.2:*

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

*REPLACE THE THIRD SENTENCE OF SUBCLAUSE 5.1.2 WITH THE FOLLOWING:*

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

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

- (a) cannot reasonably be re-established in their original positions by reason of the finished dimensions of the permanent works, and
- (b) the Contractor can prove beyond reasonable doubt to the satisfaction of the Engineer, were disturbed, damaged or destroyed by others beyond his control."

#### **PSA 5.3 PROTECTION OF EXISTING STRUCTURES**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

*REPLACE* "Machinery and Occupational Safety Act, 1983 (Act No 6 of 1983)" *WITH* "Occupational Health and Safety Act, 1993 (Act No 85 of 1993), as amended," *AND INSERT THE FOLLOWING AFTER* "(Act No. 27 of 1956)": "as amended".

#### **PSA 5.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES**

*REPLACE THE HEADING AND THE CONTENTS OF SUBCLAUSE 5.4 WITH THE FOLLOWING:*

##### **PSA 5.4.1 Location of existing services**

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

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

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

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

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

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

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

- (a) known services, anywhere along the entire lengths of their routes, as may reasonably be deduced from the actual locations at which their positions were verified as aforesaid, due cognizance being taken of such deviations in line and level which may reasonably be anticipated, and
- (b) any other service which ought reasonably to have been a known service in accordance with the provisions of this clause,

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

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

Contractor

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

**PSA 5.4.2 Protection during construction**

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

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

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

**PSA 5.4.3 Alterations and repairs to existing services**

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

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

**PSA 5.7 SAFETY**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.7 WITH THE FOLLOWING:*

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

- (a) Provide to its Employees on the site of the works, all safety materials, clothing and equipment necessary to ensure full compliance with the provisions of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993) as amended (hereinafter referred to as the Act) at all times, and shall institute appropriate and effective measures to ensure the proper usage of such safety materials, clothing and equipment at all times;
- (b) Provide, install and maintain all barricades, safety signage and other measures to ensure the safety of workmen and all persons in, on and around the site, as well as the general public;
- (c) Implement on the site of the works, such procedures and systems and keep all records as may be required to ensure compliance with the requirements of the Act at all times;
- (d) Implement all necessary measures so as to ensure compliance with the Act by all subcontractors engaged by the Contractor and their employees engaged on the works;
- (e) Full compliance with all other requirements pertaining to safety as may be specified in the Contract.

The Employer and the Engineer shall be entitled, although not obliged, to make such inspections on the site as they shall deem appropriate, for the purpose of verifying the Contractor's compliance

Contractor

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with the requirements of the Act. For this purpose, the Contractor shall grant full access to the site of all parts of the site and shall co-operate fully in such inspections and shall make available for inspection all such documents and records as the Employer's and/or Engineer's representative may reasonably require.

Where any such investigations reveal, or where it comes to the Engineer's attention that the Contractor is in any way in breach of the requirements of the Act or is failing to comply with the provisions of this clause, the Engineer shall, in accordance with the provisions of Clause 5.11 (GCC 2015) of the Conditions of Contract, be entitled to suspend progress on the works or any part thereof until such time as the Contractor has demonstrated to the satisfaction of the Engineer, that such breach has been rectified.

The Contractor shall have no grounds for a claim against the Employer for extension of time and/or additional costs if the progress on the works or any part thereof is suspended by the Engineer in terms of this clause, and the Contractor shall remain fully liable in respect of the payment of penalties for late completion in accordance with the provisions of clause 5.13.1 (GCC 2015) of the Conditions of Contract should the Contractor fail to complete the Works on or before the specified due completion date in consequence of the suspension.

Persistent and repeated breach by the Contractor of the requirements of the Act and/or this clause shall constitute grounds for the Engineer to act in terms of clause 9.2 (GCC 2010) and for the Employer to terminate the Contract in accordance with the further provisions of the said clause 9.2 (GCC 2015)

*ADD THE FOLLOWING SUBCLAUSES TO CLAUSE 5:*

**PSA 5.9 SITE MEETINGS**

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

**PSA 6 TOLERANCES**

*ADD THE FOLLOWING SUBCLAUSE TO CLAUSE 6:*

**PSA 6.4 USE OF TOLERANCES**

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

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

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

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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**PSA 7 TESTING**

**PSA 7.1 PRINCIPLES**

**PSA 7.2 APPROVED LABORATORIES**

*REPLACE THE CONTENTS OF SUBCLAUSE 7.2 WITH THE FOLLOWING:*

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

- (a) Any testing laboratory certified by the South African National Accreditation Systems (SANAS) in respect of the nature and type of testing to be undertaken for the purposes of the Contract;
- (b) Any testing laboratory owned, managed or operated by the Employer or the Engineer;
- (c) Any testing laboratory established and operated on the Site by or on behalf of the Employer or the Engineer.

*ADD THE FOLLOWING SUBCLAUSE TO CLAUSE 7:*

**“PSA7.5 SITE INSPECTIONS**

All test results obtained by the Contractor in the course of his process control of the Works shall be submitted to the Engineer or his Representative prior to requesting inspection of the relevant portions of the Works. Any request for inspection shall be submitted on the prescribed forms that will be agreed upon once the Contract has been awarded.

**PSA7.6 PROCESS CONTROL**

The Contractor shall make suitable arrangements for process control prior to commencement with the Works. Should he intend using site personnel for this purpose he shall ensure that suitably trained and competent personnel take charge of the necessary test work, and that the necessary equipment is at their disposal prior to commencement of the Works. Failure to comply with these requirements shall be just cause for the Engineer to order suspension of the Works without additional remuneration, or for him to recommend termination to the Employer in terms of the Conditions of Contract.

**PSA7.7 QUALITY ASSURANCE PROGRAMMES**

The Contractor shall deliver to the Engineer, for his consideration, quality assurance programmes (as obtained from all the Contractor's proposed suppliers of pipes, valves and specials) prior to the Contractor's appointment of any suppliers.

**PSA 8 MEASUREMENT AND PAYMENT**

**PSA 8.1 MEASUREMENT**

**PSA 8.1.1 Method of measurement, all sections of the Schedule**

*DELETE THE WORDS "and South West Africa".*

*Add the following paragraph to Sub-clause 8.1.1:*

"No measurement and/or payment will be made for overhaul. All haulage shall be regarded as freehaul and the costs thereof shall be deemed to be covered by the relevant tendered rates in the Bill of Quantities.

**PSA 8.1.2 Preliminary and General item or section**

**PSA 8.1.2.1 Contents**

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



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

#### **PSA 8.1.2.2 Tendered sums**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"Except only where specific provision is made in the Specifications and/or the Schedule of Quantities for separate compensation for any of these items, the Contractor's tendered sums under items PSA 8.3 and PSA 8.4 shall collectively cover all charges for:

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

#### **PSA 8.2 PAYMENT**

##### **PSA 8.2.1 Fixed-charge and value-related items**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.1 WITH THE FOLLOWING:*

##### **PSA 8.2.1.1 Fixed-charge items**

"Payment of fixed charges in respect of item 8.3.1 will be made as follows:

- (a) EIGHTY PER CENT (80%) of the sum tendered will be paid when the facilities have been provided and approved;
- (b) The remaining TWENTY PER CENT (20%) will be paid when the works have been completed, the facilities have been removed and the site of the Contractor's establishment has been cleared and cleaned to the satisfaction of the Engineer.

No adjustment will be made to the sum tendered in respect of item 8.3.1 should the value of the works finally executed or the time for completion vary in any way from that specified in the tender.

##### **PSA 8.2.2 Time-related items**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.2 WITH THE FOLLOWING:*

"Subject to the provisions of subclauses 8.2.3 and 8.2.4, payment under item 8.4.1 (time-related item) will be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the tendered Contract period in months, provided always that the total of the monthly amounts so paid for the item is not out of proportion to the value of the progress of the Works as a whole."

#### **PSA 8.3 SCHEDULED FIXED-CHARGE AND VALUE-RELATED ITEMS**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.1 WITH THE FOLLOWING:*

##### **PSA 8.3.1 Fixed preliminary and general charges ..... Unit: Sum**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



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

#### **PSA 8.4 SCHEDULED TIME-RELATED ITEMS**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.4 WITH THE FOLLOWING:*

##### **"PSA 8.4.1 Time-related preliminary and general charges ..... Unit: Sum**

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

*ADD THE FOLLOWING SUBCLAUSE TO CLAUSE 8.4.5:*

##### **"PSA 8.4.5.1 Supervision and Training of Nominated Sub-Contractors**

The Contractor shall provide a rate for supervision and training of nominated sub-contractors under the project. A total of two sub-contractors will be nominated to the main contractor of which the Contractor will be responsible for the following:

- Day to day administration of the sub-contractor;
- Training of the sub-contractor to ensure quality works as per the project specification;
- Payment of monies due to the sub-contractor for works done.

Any matters relating to nominated sub-contractors shall be addressed as per clause 5 of the general conditions of contract.

##### **PSA 8.4.5.2 Salary for Labour Desk Officer and Community Liaison Officer**

The Contractor shall provide a Sum in Schedule 1 for a salary to be paid to the Labour Desk Officer and Community Liaison Officer. This amount will also be utilized for payment of the following:

- Payment of any skilled personnel as per instruction of the client. This will include technicians working for the Client, storekeeper, security personnel etc.

##### **PSA 8.4.5.3 Artisans and Skills Training**

The Contractor shall provide a Sum in Schedule 1 for payments to be made to specialists for the training of unskilled or semi-skilled persons in industry accredited management and generic skills. An allowance must be made for wages and salaries of such labourers under a separate payment item. Payment to the Contractor will be based on invoices certified by the Engineer and issued by training specialists to the Contractor for work undertaken in terms of this item.

##### **PSA 8.4.5.4 Specialized Services**

The Contractor shall provide a Sum in Schedule 1 for the appointment and payment for specialized services. These may include all work required by the following specialists:

- Environmental compliance monitoring by the ECO;
- Acceptance control testing of pipework, coatings and linings"

#### **PSA 8.5 SUMS STATED PROVISIONALLY BY THE ENGINEER**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.5 WITH THE FOLLOWING:*

##### **"PSA 8.5.1 Works executed by the Contractor Unit: Prov Sum**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor will be reimbursed in substitution of the Provisional Sums (if any) allowed in the Schedule of Quantities for work to be executed by the Contractor, in the amounts determined in accordance with the provisions of Clause 6.6 (GCC 2015).

**PSA 8.6 PRIME COST ITEMS**

*REPLACE SUBCLAUSE 8.6 WITH THE FOLLOWING:*

**“PSA 8.6 PRIME COST SUMS**

- (a) Description of item to which Prime Cost Sum applies ..... Unit: PC Sum  
(b) Charge required by Contractor on subitem (a) above ..... Unit: %

Subitems (a) and (b) will be provided in the Schedule of Quantities for each different item to which a Prime Cost Sum applies.

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

The Contractor shall be paid under subitem (b), the respective percentage, as stated by the Contractor in his tender, of the amount certified by the Engineer for payment under the related subitem (a). The percentages tendered by the Contractor for each respective subitem (b) included in the Schedule of Quantities shall be deemed to be in full and final compensation to the Contractor in respect of any charge by the Contractor for labour, carriage profit, establishment and for any other charges related to the goods, services or materials supplied under the related subitem (a).

If the Contractor shall have omitted within his tender to insert a tendered percentage under subitem (b), or tendered a zero percentage, the Contractor's tendered rate for subitem (b) shall be deemed to be zero and the Contractor shall not be entitled to any payment under subitem (b).

Note in connection with additional tests required by the Engineer:

When a PC sum is included in the Schedule of Quantities for additional tests required by the Engineer, the Contractor shall be responsible for both the cost of normal testing as described in the Project Specifications and for the cost of any additional test that indicates that the specifications have not been complied with."

**PSA 8.7 DAYWORK**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.7 WITH THE FOLLOWING:*

"Measurement and payment shall be in accordance with the provisions of Clause 6 (GCC 2015 of the Conditions of Contract.)"

*ADD THE FOLLOWING SUBCLAUSES:*

**PSA 8.8 COMPLIANCE WITH OHS ACT AND REGULATIONS**

**(INCLUDING THE CONSTRUCTION REGULATIONS 2003)** ..... Unit: Sum

The tendered sum shall include full compensation to the Contractor for compliance with all the requirements of the OHS Act and Regulations (including the Construction Regulations 2014) at all times for the full duration of the Contract, as described in C1.2 Annex D and C3.5.2- Health and Safety. The successful tenderer shall provide the Engineer with a complete breakdown of this tendered sum.

This sum will be paid to the Contractor in equal monthly amounts subject to proper/substantial compliance."

**PSA 8.9 COMPLIANCE WITH ENVIRONMENTAL LEGISLATION**

Description of item to which Prime Cost Sum applies ..... Unit: Sum

The tendered sum shall include for the full duration of the Contract compliance with Environmental Management Plan (EMP) as described in C1.2 Annex C and C3.5.3.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

## PSAB: ENGINEER'S OFFICE

(Applicable to SANS 1200 AB - 1988 as amended 1990)

### PSAB 3 MATERIALS

#### PSAB 3.1 NAMEBOARDS

*REPLACE THE FIRST SENTENCE OF SUBCLAUSE 3.1 OF SANS 1200 AB WITH THE FOLLOWING:*

"The Contractor shall supply and erect at locations approved by the Engineer, the number of contract nameboards as specified, which, unless otherwise specified in the Contract, shall comply with the recommendations for the standard board of the South African Association of Consulting Engineers with regard to size, painting, decorating and detail, and the requirements described hereunder."

### PSAB 4 PLANT

#### PSAB 4.4 SURVEY EQUIPMENT

The Contractor shall provide on site and make available for the exclusive use of the Engineer and his staff, survey equipment

All survey equipment provided by the Contractor shall be in good condition, properly calibrated and fit for the purpose.

In addition to survey equipment provided by the Contractor for the exclusive use of the Engineer and his staff, the Contractor shall make available for use by the Engineer, the further survey equipment listed as agreed with the RE at all times when such is reasonably required by the Engineer and his staff for the purposes of the Contract.

### PSAB 5 CONSTRUCTION

#### PSAB 5.4 TELEPHONE

*REPLACE THE CONTENTS OF SUBCLAUSE 5.4 OF SABS 1200 AB WITH THE FOLLOWING:*

##### "PSAB 5.4.1 Telkom telephones

Not Applicable

##### PSAB 5.4.2 Cellphones

The Contractor shall advise the cellular service provider of any faults which develop in the cellphone service and/or the cellphone handsets and shall, in such circumstances, arrange for the earliest possible restoration of the said service.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The costs of any necessary repairs and/or the replacement of components to the handsets of the cellphones shall be for the Contractor's account.

The Contractor shall ensure that all accounts for cellphone calls and the respective service contracts are promptly paid. The Contractor shall, on production of an itemised statement, be reimbursed only for the cost of the Engineer's cellular telephone calls."

*ADD THE FOLLOWING NEW SUBCLAUSES TO CLAUSE 5 OF SABS 1200 AB:*

#### **"PSAB 5.6 COMPUTER EQUIPMENT**

All computer equipment provided shall be kept fully serviceable at all times by the Contractor. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

The Contractor shall further provide at his own cost, all paper and black ink cartridges and other consumables reasonably required by the Engineer.

#### **PSAB 5.8 SURVEY EQUIPMENT**

All survey equipment provided by the Contractor shall be kept fully serviceable at all times by the Contractor. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

Survey equipment listed below shall be made available and be maintained in good condition for the exclusive use of the Engineer or his Representative for the duration of the Contract. Payment will be made as provided for in the Time Related Items included in Schedule 1.

- |     |                                                                                                                             |       |
|-----|-----------------------------------------------------------------------------------------------------------------------------|-------|
| (a) | Automatic surveyor's level complete with tripod and leather carry case such as Zeiss N1-2 or equivalent.                    | 1 No  |
| (b) | 20-second tachometer with optical plumbob complete with tripod and leather carry case such as Sokkisha TM20C or equivalent. | 1 No. |
| (c) | Nylon-coated steel surveyor's tape 100m long and 10mm wide.                                                                 | 1 No. |
| (d) | 5m long steel tape.                                                                                                         | 1 No. |
| (e) | 5m long three-piece telescopic survey staves (metric double-face) complete with angle bracket level.                        | 1 No  |
| (f) | Survey books: Level.                                                                                                        | 2 No. |
| (g) | One metre long spirit level.                                                                                                | 1 No. |

### **PSC: SITE CLEARANCE**

(Applicable to SANS 1200 C - 1980 as amended 1982)

#### **PSC 3 MATERIALS**

##### **PSC 3.1 Disposal of material**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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*Substitute the first sentence of C 3.1 with the following:*

Material obtained from clearing and grubbing and demolition structures shall be disposed of at disposal sites identified by the Contractor off the Site and in a manner approved by the Engineer.

*Add the following to C 3.1:*

No measurement and/or payment will be made for overhaul. All haulage shall be regarded as freehaul and the costs thereof shall be deemed to be covered by the relevant tendered rates in the Bill of Quantities.

## **PSC 5 CONSTRUCTION**

### **PSC 5.1 Areas to be cleared and grubbed**

*Add the following to C 5.1:*

"The following areas are to be cleared and grubbed:

- i) The routes of the pipeline section to be replaced and the bypass pipeline.
- ii) Sites where new buildings will be constructed.

."

### **PSC 5.5 Re-clearing of vegetation**

*Add the following to C 5.5:*

"When areas have to be re-cleared on the written instructions of the Project Manager, 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."

### **PSC 5.8 Demolition of structures**

Add the following Sub-clauses to Sub-clause 5.8:

#### **PSC 5.8.1 Demolition of existing valve chambers**

Where specified, the Contractor shall demolish existing valve chambers and dispose of the rubble at disposal sites identified by the Contractor off the Site and in a manner approved by the Engineer. Recovered valves and pipe fittings shall be transported to the designated storage place.

## **PSC 8 MEASUREMENT AND PAYMENT**

### **PSC 8.2 Payment**

#### **PSC 8.2.1 Clear and grub**

*REPLACE THE FIRST LINE WITH THE FOLLOWING:*

"The area designated by the Engineer to be cleared and grubbed will be measured in square metre to the nearest square metre or, "



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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## **PS C 8.2.8 Demolish and remove structures/buildings and dismantle steelwork**

*Add the following to C 8.2.8:*

### **PS C 8.2.8.1 Demolition of existing valve chambers**

Separate items will be scheduled for each type and size valve chamber to be demolished and will be measured by number. The rate shall include for removing and transporting fittings from the chamber to the designated storage place, all excavation required to demolish the chamber, demolition of the chamber and disposal of the rubble as specified in Clause PSC 3.1, and if required, backfilling of the hole left by the demolition of the chamber.

## **PSDA: EARTHWORKS (SMALL WORKS)**

(Applicable to SANS 1200 DA - 1988 as amended 1990)

### **PSDA 2 Interpretations**

#### **PSDA 2.3 Definitions**

Add the following to DA 2.3:

Sand (cohesionless and non-cohesive)

For the purpose of the compaction requirements, a non-plastic material of which not less than 95% by mass passes a sieve of nominal aperture size 4.75 mm, and not more than 10% passes a sieve of nominal aperture size 0.075 mm.

### **PSDA 3 Materials**

#### **PSDA 3.1.2 Classes of excavation**

Notwithstanding the provisions of Sub-clause DA 3.1.2 the excavation of material will not be classified except for hard rock excavation. All excavation will be considered to be carried out in all materials except where the material is hard rock. No separate measurement nor payment will be made for any variations in materials except for hard rock excavation.

Add the following new Sub-clause:

#### **PSDA 3.1.3 Selection of materials from excavations**

The Contractor shall deal in such a way with materials from all excavations for structures and pipe trenches to ensure that usable material is not contaminated with unsuitable material. If usable material is contaminated, such contaminated material shall be removed and replaced with material of standard at least equal to the in situ usable material, all at the Contractor's expense. No additional payment shall be made in respect of this and all relevant costs shall be deemed to be included in the tendered rates.

### **PS D 4 Plant**

Add the following new Sub-clause to DA 4:

#### **PSDA 4.3 Avoiding quagmire conditions**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



In order to prevent quagmire conditions occurring in the excavations, relatively static plant such as back-actors shall be used combined with hand trimming to complete the excavation to final level. Should the Contractor allow quagmire conditions to develop, he shall, at his own expense, take such steps to rectify the conditions as the Engineer may order.

## **PSDA 5 CONSTRUCTION**

### **PSDA 5.1 Precautions**

#### **PSDA 5.1.1 Safety**

In Sub-clause DA 5.1.1 replace all references to the "Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)" with the "Occupational Health and Safety Act (Act No. 85 of 1993) (OHS Act) and the Construction Regulations, 2014."

#### **PSDA 5.1.1.2 Safeguarding of excavations**

Insert the following after paragraph (b)(2), before paragraph (c):

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

#### **PSDA 5.1.1.3 Explosives**

Add the following to DA 5.1.1.3:

The use of explosives in the proximity of services is subject to the approval and conditions stipulated by the service authority.

When blasting is permitted, only light charges shall be used. The Contractor shall in all cases be entirely responsible for any damage caused by blasting operations, and shall settle all claims resulting at his own expense.

The Contractor shall conform to all statutory and other regulations regarding blasting and the handling of explosives. All blasting shall be done under the control of persons holding valid blasting certificates for blasting in streets.

The Contractor shall make his own arrangements for the supply, transport and storage of all explosives and detonators in accordance with the requirements of the Chief Inspector of Explosives and the South African Police Services.

Explosives and detonators may be kept on the site outside normal working hours only if proper magazines are installed and maintained in accordance with all requirements of the above mentioned authorities.

No separate or additional payment will be made for blasting. The Contractor shall allow for all blasting costs in his prices for the relevant items of earthworks, excavations, demolitions, etc.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

#### **PSDA 5.1.1.4 Barricading of trenches**

Add new Sub-clause D 5.1.1.4:

The Engineer may request that trenches must be barricaded due to reasons that he sees fit. The barricade will be at least 1.2 metres high and the distance between wire strands will not exceed 200 mm if a wire fence is erected. If a barricade net is erected the openings in the net will not exceed 100 x 100 mm. The barricade (net or wire fence) will be supported at distances not greater than 1 metre with suitable sturdy supports.

After completion of the work(s) the barricades must be removed completely and no barricading material may be left on site. The barricade will be erected on both sides of the trench with a minimum distance of 5 metres and a maximum distance of 10 metres from the side of the trench.

#### **PSDA 5.1.3 Existing services**

Add the following to DA 5.1.3:

If existing services are not shown on the drawings but the existence thereof can be reasonably expected, the Contractor shall, in conjunction with all relevant authorities, determine the exact path and location of such services before the commencement of construction. After locating the exact position of services, whether indicated on the drawings or not, such services shall be deemed to be known services and the Contractor shall be liable for all costs and subsequent costs arising from the damage thereof as a result of the Contractor's activities. These services must also be indicated on the "Record" drawings.

All services must be located and opened for inspection by the Project Manager before commencing trench excavation. Any costs or losses suffered by the Contractor as a result of not abiding by this specification will be for the Contractor's account.

#### **PSDA 5.1.5 Excessive pollution**

Add the following to DA 5.1.5:

The Contractor is responsible for dust control and is liable for all claims that may result from dust nuisance on all parts of the site and at all times from the date of handing over of the site to the completion date of the contract. No payment regarding the above-mentioned will be made and all costs shall be deemed to be covered by the tendered rates.

#### **PSDA 5.1.8 Road traffic control**

Add the following to D 5.1.8:

- a) Road traffic signs shall comply with the requirements of the "South African Road Traffic Signs Manual" and shall be approved by the Engineer before construction commences.
- b) Sufficient road signs must be erected in such a way that motorists will be warned in time of works, e.g. at the closing of a street/road sufficient signs to direct traffic must be erected at the preceding intersection.
- c) Bypasses and/or road signs shall be provided and/or erected at locations where the free flow of traffic is obstructed and shall be approved by the Engineer before the commencement of construction.
- d) Where a trench crosses a street/road or any place where a trench crosses the direction of traffic flow, drums must be placed in the street and not just along the sides of the street with danger tape in between.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- e) Danger tape must be put up between drums and tied around the drums.
- f) Drums may not be filled with stones. The spacing of drums must be in such a way (maximum 5 m) that they are visible from all directions.
- g) Sufficient safety measures must be utilised for pedestrians.

No additional payment for compliance with the above-mentioned conditions will be made and all costs (labour, road traffic signs, etc.) shall be deemed to be included under other items.

## **PSDA 5.2 Methods and procedures**

### **PSDA 5.2.2 Excavation**

Add the following to DA 5.2.2 (a):

Removal of topsoil shall only occur in areas as approved by the Engineer. The topsoil shall be conserved for use elsewhere. Topsoil shall be deposited from the excavations and stockpiled separately in temporary stockpiles. In order to conserve the bacteriological life in the topsoil the storage heaps, strips or layers shall not exceed 1.5 m in total depth.

To the maximum extent possible all suitable materials excavated shall be used in the construction of the works. Such materials shall be selected from the unsuitable materials and stockpiled separately in temporary stockpiles on sites to be negotiated by the Contractor and approved by the Project Manager.

The assessment of the quantity of suitable material to be stockpiled for filling shall be the responsibility of the Contractor entirely and any deficit shall be made good by the Contractor without cost to the Employer. The balance of the suitable material for filling which is assessed as surplus to the requirements of the work may be removed from the sites as excavations proceed.

Add the following to DA 5.2.2 (b):

Strip foundations and encasement of pipes shall be cast directly against excavated surfaces.

Add the following to DA 5.2.2 (d):

Materials under foundations and floors of structures, which are regarded by the Engineer as unsuitable for the bearing of such structures shall be removed to the depths and widths, ordered. The excavated voids shall then be filled with sand compacted to 100% of Modified AASHTO density, to the underside of such foundation or floors, unless a soil cement mixture in terms is ordered by the Engineer.

Add the following new Sub-clause DA 5.2.2 (e):

All surplus material and all unsuitable material from excavations for the rehabilitation of the canal shall be disposed of within the canal servitude in areas approved by the Engineer.

Dumping shall proceed in an orderly manner with coarse material placed at the bottom and covered with finer material, where possible. Upon completion of dumping the material shall be shaped to provide free-draining surfaces and slopes and finished off to the satisfaction of the Engineer.

All surplus and unsuitable material from other excavations shall be transported to, dumped and neatly finished off at a municipal dumping site to be identified by the Contractor. The use of the disposal area must be confirmed with the Engineer prior to disposal. No payment will be made for



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

overhaul and all transport shall be regarded as freehaul and the costs thereof shall be included in the tendered rate.

Add the following new Sub-clause DA 5.2.2 (e):

Where no excavation limits are shown on the Drawings and the Engineer has decided that formwork has to be provided to the sides of a concrete member, the limits of the excavation for measurement and payment purposes shall be the vertical planes 0.6 m outside the perimeter of the concrete member for which the formwork is to be provided at the founding level as shown on the Drawings.

### **PSDA 5.2.3.2 Restricted backfill and compaction at structures**

Add the following to DA 5.2.3.2:

Unless otherwise authorised by the Engineer no backfilling or filling against structures shall commence until the concrete has been in place for at least 14 days.

Backfilling of all pipe trenches and around structures shall be performed in 150 mm thick layers with material approved by the Engineer, each layer shall be compacted to 95% Modified AASHTO maximum dry density at optimum moisture content with sufficient water added uniformly to ensure that the specified density will be achieved for each layer. Each layer shall be completed before the next is added. Backfilling is not measured separately but is included in the tariff for the chambers. All over-excavation must be backfilled by the Contractor with mass concrete of the specified grade at his own cost. Where such over-excavation has been ordered by the Engineer, the backfilling with concrete will be measured and paid for separately.

When specified or ordered by the Engineer the backfilling against structures shall be done using a mixture of soil and cement. The mixture shall contain 5% cement and just sufficient water for it to be placed and compacted like ordinary backfilling material.

### **PSDA 5.2.5.2 Top soiling**

Add the following to DA 5.2.5.2:

After the backfilling of the excavations has been completed to the subsoil surface the topsoil shall be returned to the upper 300 mm layer from which it was removed to restore the natural ground surface. The topsoil shall be evenly spread and lightly compacted to leave the upper ground surface in a neat and tidy condition as near as may be to the original condition encountered before excavation commenced or to such details for the embankments as are indicated on the drawings.

### **PSDA 5.2.6 Transport for earthworks**

#### **PSDA 5.2.6.1 Freehaul**

Substitute DA 5.2.6.1 with the following:

Notwithstanding any clause in any standardized specification in respect of the definition, no payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Bill of Quantities.



Contractor



Witness 1



Witness 2



Employer



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Witness 2

### **PSDA 5.2.6.2 Overhaul**

Substitute D 5.2.6.2 with the following:

Notwithstanding any clause in any standardized specification in respect of the definition, no payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Bill of Quantities.

Add the following new Sub-clauses to DA 5.2:

### **PSDA 5.2.7 Dewatering of foundation excavations**

Over and above his general obligations in regard to dealing with water as specified in SANS 1200 A, the Contractor shall deal with and dispose of all water so as to ensure that the Works are kept sufficiently dry at all times so that they can be properly executed, and he shall protect them against flood damage.

For this purpose the Contractor shall provide sufficient pumps, pipes and other equipment that may be necessary. Where necessary, the Contractor shall construct temporary berms, culverts and channels to drain away the water.

Payment for dealing with water shall be included in the Contractor's rates for preliminary and general charges, except in so far as special provision for dealing with water may be made elsewhere in the Specifications. Provision will be made for 19 mm crushed stone, dump rock and Geotextiles in the Schedule of Quantities.

### **PSDA 5.2.8 Setting out of excavations**

The Contractor shall set out the excavations accurately in accordance with the drawings and data supplied by the Engineer.

The Contractor shall provide, erect, set to line and level and maintain approved substantial working profiles on the perimeter of excavations and along the length of the trench at changes of grade and direction. Each working profile shall be fitted with a horizontal cross-bar set at a predetermined height above the designed excavation profiles to which excavations are to be carried out and have setting marks which will define the local setting out lines and the centre line of the trench. Where required by the Engineer the Contractor shall provide a working profile with the cross-bar extending across the full width of the trench. A working profile shall remain in position during all stages of the excavations until the concrete is placed or the pipe is laid past the chainage of the working profile.

The Contractor shall provide sets of boning rods, templates and piano wire, for the sole use of the Engineer, for checking the profiles of the excavations. The Contractor shall also provide, set and level all the pegs required to transfer lines and levels to the excavation floor in order to control the preparation of the prescribed profiles.

### **PSDA 5.2.9 Safety of excavations**

Excavations shall be undertaken in a safe manner in compliance with the regulations promulgated under the Occupational Health and Safety Act (Act 85 of 1993) or any amendment thereof. Safety precautions to be observed by the Contractor shall include the sloping, stepping or benching or shoring, timbering or otherwise supporting the sides of the excavations or any other provision as



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stipulated in the regulations of the aforesaid act, with which the Contractor declares himself to be conversant.

The shoring method adopted shall be compatible with the excavating, backfilling and construction method and shall not restrict the installation and construction. Shores shall be designed to withstand the earth pressures exerted upon them from the side of the excavation which shall include the superimposed loading of construction and pipe laying equipment.

The Engineer may call upon the Contractor to timber the sides of the excavation at any point, without cost to the Employer, which he may consider in any way dangerous. Such timbering shall be left in place until the completion of the work at the point affected. Timbering shall consist of open planning, wallings and substantial struts and shall be carried out in a workmanlike manner and to the satisfaction of the Engineer. The Contractor shall allow for the removal of timbering immediately prior to backfilling or on the instructions of the Engineer.

#### **PS D 5.2.10 Maintaining the sides of excavations**

Maintaining the sides of the excavations in a safe condition shall at all times be the sole responsibility of the Contractor. No under-cutting of the sides will be allowed.

#### **PS D 5.2.11 Protection of work**

The Contractor shall provide, at his own expense, all measures necessary for the protection of the excavations during the progress of the work, and shall be solely responsible for securing, lighting and watching all places dangerous to traffic, persons, animals or property, and shall be liable for all claims arising therefrom.

The excavations shall be maintained until the structures are completed and backfilled. Should the sides fall in or any debris or water accumulate in the excavations due to any cause the excavation shall be cleaned out and any damage arising therefrom made good by the Contractor at his own cost as directed by the Engineer.

#### **PS D 5.2.12 Source of materials**

Unless authorised by the Engineer, suitable material shall be selected from materials excavated under the contract. If insufficient suitable material for filling is available for selection from the excavations the Contractor shall with the approval of the Engineer, supplement the available suitable material for filling by importing suitable material approved by the Engineer. The Contractor shall negotiate for, obtain, load and transport to site the supplementary requirements for filling. No payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Schedule of Quantities.

### **PSDA 7 TESTING**

#### **PSDA 7.2 Testing**

Delete Sub-clauses 7.2 and 7.3 and replace with:

"The Contractor shall arrange for all necessary process control tests for soil properties, density, etc, and is responsible for the cost of all testing to ascertain that the materials do comply with the relevant minimum requirements and all costs shall be deemed to be included in the tendered rates. The cost of acceptance control tests done by the Engineer, of which the results do not



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comply with the minimum requirements, shall be for the Contractor's account. These tests must be carried out by an independent laboratory approved by the Engineer.

The Contractor shall inform the Engineer of any process control testing to be done at least 48 hours before such test is required and must allow in his programme for the time necessary for the tests and the processing of the results thereof."

## **PSDA 8 MEASUREMENT AND PAYMENT**

### **PSDA 8.1 Basic principles**

Add the following to DA 8.1:

The rates for excavation shall also cover the cost of dealing with any stormwater or subsurface water, which may appear in the excavations.

Since excavation except hard rock excavation will not be classified on the basis of Sub-clause 3.1.2, the rates for excavation shall be deemed to include for excavation in all materials except hard rock excavation.

The provision of working space (see Sub-clause 8.3.5) will not be measured for payment. Notwithstanding the provisions of Sub-clause 8.1.3, the Contractor shall make his own allowance for the excavation of any working space required for formwork or other purposes. The rates for restricted excavation shall also cover the costs of providing working space.

### **PSDA 8.3 Scheduled items**

#### **PSDA 8.3.1 Excavation**

Add the following sub items to DA 8.3.1:

- c) Extra-over 8.3.1(a) for soil cement backfilling where specifically required by the Engineer (percentage of cement indicated) ..... Unit : m<sup>3</sup>

The tendered rate for sub item PSDA 8.3.1(c) shall be additional to the rates tendered for DA 8.3.1(a) and shall cover the cost of all incidentals required for the complete backfilling with soil cement as specified. The rate shall also include for the trimming and compacting of the excavation before placement of soilcrete.

- d) Excavate and dispose of unsuitable material from excavation bottom ..... Unit : m<sup>3</sup>

The rate shall cover the cost of complying with all the precautions required in terms of DA 5.1 in addition to the cost of excavation of the additional depth in any material and the disposal of the unsuitable material as specified in PSDA 5.2.2.

- e) Extra-over 8.3.1(a) for trimming and compacting terraces ..... Unit : m<sup>2</sup>

The rate includes for the trimming and compacting of horizontal and sloping sides of the terraces before top soil and grass is placed, including for the removal of large stones and rubble to form a uniform surface.

#### **PSDA 8.3.2 Restricted excavation**



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Employer



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Witness 2

Restricted excavation shall be limited to those excavations detailed on the drawings or as agreed to by the Engineer as being restricted.

Add the following sub items to D8.3.2

- c) Extra-over 8.3.2(a) for soil cement backfilling where specifically required by the Engineer (percentage of cement as specified) ..... Unit: m<sup>3</sup>

The tendered rate for sub-item PSDA 8.3.2(c) shall be additional to the rates tendered for D 8.3.2(a) and shall cover the cost of all incidentals required for the complete backfilling with soil cement as specified. The rate shall also include for the trimming and compacting of the excavation before placement of soilcrete.

- d) Excavate and dispose of unsuitable material from excavation bottom ..... Unit : m<sup>3</sup>

The rate shall cover the cost of complying with all the precautions required in terms of DA 5.1 in addition to the cost of excavation of the additional depth in any material and the disposal of the unsuitable material as specified in PSDA 5.2.2.

- e) Extra-over 8.3.2(a) for trimming and compacting terraces .....Unit : m<sup>2</sup>

The rate includes for the trimming and compacting of horizontal and sloping sides of the terraces before topsoil and grass is placed, including for the removal of large stones and building rubble to form a uniform surface.

### PSDA 8.3.3 Overhaul

Substitute DA 8.3.3 with the following

Notwithstanding any clause in any standardized specification in respect of the definition, no payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Schedule of Quantities.

## PSDB: EARTHWORKS (PIPE TRENCHES)

(Applicable to SANS 1200 DB - 1988 as amended 1990)

### PSDB 1 SCOPE

*ADD THE FOLLOWING TO THIS CLAUSE:*

The provisions of this specification shall apply mutatis mutandis to portal and rectangular precast concrete culverts.

### PS DB 2.3 Definitions

*Add the following to DB 2.3:*

#### Topsoil

Topsoil is defined for the purpose of this Contract as the upper layer of soft material with a depth not exceeding 300mm below the natural ground surface in which veld or cultivated grass is growing.



Contractor



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Before proceeding with the bulk excavation the Contractor shall strip the topsoil over the width of the pipe trench and place it in stockpiles, heaps or layers separate from other excavated material for later replacement in the upper layer of the backfilled trench. In order to conserve the bacteriological life in the topsoil, the storage heaps, strips or layers shall not exceed 1.5m in height.

After the backfilling of the trench has been completed to within 300mm of the natural ground level, the topsoil shall be returned to the upper 300mm layer from which it was removed. The topsoil shall be evenly spread and lightly compacted to leave the upper ground surface in a neat and tidy condition as near as possible to the original condition encountered before excavation commenced.

No topsoil shall be transported from the area from which it was excavated.

### **PSDB 3 MATERIALS**

#### **PSDB 3.1 CLASSES OF EXCAVATION**

*ADD THE FOLLOWING TO THIS SUB-CLAUSE:*

Notwithstanding the provisions of Sub-Clause 3.1, the materials excavated other than hard rock will not be classified for purposes of measurement and payment. The unit rate for excavation shall cover excavation in all materials other than hard rock and where scheduled separately boulders classes A and B (as specified in SANS 1200DA sub-clauses 3.1.2d and 3.1.2e).

#### **PSDB 3.5 BACKFILL MATERIALS**

In paragraph (a) insert "and (c)" after "(b)" in the first line.

Renumber paragraph (b) as "(c)" and insert the following new paragraph (b):

(b) In the particular area subject to road traffic which lies between lines 2,0m beyond edge of roadway and 1,0m beyond back of kerb for barrier kerbs, hereinafter referred to as "areas under roadways", the material used for backfill shall be one of the following:

- (i) A sub-base quality material conforming to the requirements of SANS 1200ME compacted in 150mm layers to 93% Mod. AASHTO density.
- (ii) An approved selected granular material compacted in 150mm layers to 93% Mod. AASHTO density.

Amend paragraph (c) by the insertion after the word "traffic" of the words "other than under roadways". Add "The materials specified herein shall be used for backfill under paved sidewalks and in other areas ordered by the Engineer."

Under roadways and at depths exceeding 3 metres the maximum trench width below the crown of the pipe shall not exceed the minimum specified by more than 20%. Should these widths be exceeded the Contractor shall at his own cost provide a higher class bedding than that called for to give the equivalent structural strength and where this is not practicable take such other measures to the approval of the Engineer as are necessary to attain this result.

*Add the following new subclauses*

- (d) Cement-stabilised backfilling



Contractor



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Witness 2



Employer



Witness 1



Witness 2

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

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

(e) Soilcrete backfilling

The aggregate for soilcrete shall be mixed with 5% cement and shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

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

**PSDB 3.7 Selection**

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

**PSDB 5 CONSTRUCTION**

**PSDB 5.1 PRECAUTIONS**

**PSDB 5.1.1 General**

*Add new subclause DB 5.1.1.1 to DB5.1.1:*

**PS DB 5.1.1.1 Water in trenches**

Water in pipe trenches may cause movement of the pipes as a result of flotation and backfilling must therefore be executed as quickly as possible. If movement of the pipes does occur the Contractor must, unless otherwise instructed by the Engineer, remove the pipes from the trench and reinstall it at his own expense.

**PSDB 5.1.2 Stormwater, Seepage and Dewatering of Excavations**

**PSDB 5.1.2.2 Special Water Hazards**

*ADD THE FOLLOWING:*

No specific items will be scheduled for special water hazards; the Contractor shall include for dealing with all water in his tendered rates for earthworks. The costs of dealing with water shall be deemed to be included in the tendered rates for excavation and no additional payment shall be made in this respect.

*ADD THE FOLLOWING TO SUB-CLAUSE 1200DB 5.1.4:*

**PSDB 5.1.3 Accommodation of Traffic and Access to Properties**

*ADD THE FOLLOWING AT THE END OF SUB-CLAUSE 5.1.3*

The Contractor shall draft a traffic accommodation plan and submit to the Engineer prior to commencement of work on any road. The approval by the Engineer shall not relieve the



Contractor



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Contractor of any of his responsibilities or obligation. The plan should comply with provisions of SANS 191-2 in terms of road signage, barricading, detours etc.

#### **PSDB5.1.4 Existing Services**

**ADD THE FOLLOWING TO SUB-CLAUSE 5.1.4:**

Where any existing service occurs within the specified trench excavation, and the presence of such service is known before being uncovered, then the protection of the service will be scheduled and measured as provided for in Clause 8.3.5 of 1200DB. Only known services (as defined in Clause 5.4 of 1200A) shall be measured for payment.

Where an unknown existing service is damaged during construction, and the Engineer orders that the Contractor should undertake the repair of such service, then such repair will either be measured and paid as dayworks or alternatively as a contractual variation in terms of Clause 13 of the Conditions of Contract.

No construction activity which may affect the integrity of telephone or electrical poles or stays may be carried out without the prior written approval of the Engineer, which approval shall only be given subject to the acceptance of a *modus operandi* that will ensure the integrity of such structures during construction."

**ADD THE FOLLOWING SUB-CLAUSES:**

#### **"PSDB 5.1.5 Maximum length of open trench**

The Contractor shall plan his operations in such a manner that the length of trench excavation remaining open shall be restricted to the absolute minimum. No excavation for prefabricated culverts may be commenced until the pipes or culverts to be installed are on site, and the excavations shall be backfilled within seven days of the pipes or culverts being installed. Unless otherwise permitted by the Engineer in writing the total length of open trench shall not exceed three hundred (300) metres. Regardless of any approval or permission granted by the Engineer, the Contractor shall comply with any restrictions on length of trench contained in his insurance policy. All manholes, catchpits, kerb inlets, etc., shall be completed and backfilled at the same time as the installation of the prefabricated culverts."

#### **PS DB 5.1.6 Hand excavation**

Certain trenches will have to be excavated by hand, because of limited access and space. The Contractor is to ensure that all excavation done by hand is in strict accordance with the requirements of the Occupational Health and Safety Act.

#### **PSDB 5.1.7 Removal of existing pipelines**

Where existing pipes have to be removed, they shall be carefully opened up by machine excavation to 300 mm above the pipes after which the whole pipe shall be fully exposed by means of hand excavation. The excavation width shall comply with Sub-clause 5.2.

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

Pipes that are declared suitable for re-use and pipes declared unfit for re-use shall be dealt with in accordance with the respective manner described in the specifications, or on the drawings or the Engineer's instructions, as relevant."



Contractor



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### **PSDB 5.1.8 Working in the vicinity of Eskom high voltage overhead power lines**

Before commencing any excavation or backfilling a pipe trench under or in the vicinity of Eskom high voltage overhead power lines, the Contractor shall obtain the necessary written authorisations from Eskom and shall submit copies of any such authorisations to the Engineer. No separate payment shall be made to the Contractor for compliance with this requirement. The cost of obtaining the authorisations and any special working methods imposed by Eskom for site clearing, trench excavation, pipe laying, backfilling the trench, reinstatement of the area and any other related activity, shall be deemed to be covered by the Contractor's other tendered rates.

### **PSDB5.4 Excavation**

*ADD THE FOLLOWING TO THE SUB-CLAUSE:*

"The Contractor will be required to follow a procedure, whereby laying, jointing, testing and backfilling for each section of the pipeline will follow soon after trenching, and he will not be permitted to open up lengths of trench far in advance of pipelaying and backfilling operations. If in the opinion of the Engineer, trenching has proceeded too far ahead of pipelaying and backfilling, the Engineer shall have the right to stop trenching until the pipelaying and backfilling has caught up and the Contractor shall not be entitled to any extra payment due to this instruction."

### **PSDB 5.5 TRENCH BOTTOM**

*EXTEND THE SUB-CLAUSE TO INCLUDE THE FOLLOWING:*

- (a) On completion of excavation, before the bottom is trimmed or bedding is placed, the bottom of the trench in suitable material shall be so compacted that the density of the upper 100mm thick layer of material is 90% of modified AASHTO density.
- (b) Should the nature of the material be such that the specified density cannot be achieved the bottom of the trench shall be over-excavated, the bottom of the over-excavation compacted, and the excavated material replaced and compacted; the depths of over-excavation, which shall be agreed with the Engineer, shall be such that the specified density is attained at the bottom of the trench.
- (c) Where, in the opinion of the Engineer, the trench bottom is unacceptably wet or unstable due to the presence of ground water (but not due to negligence on the part of the Contractor) the Engineer will order the Contractor to over-excavate the trench and refill with a 200mm thick layer of 6,7mm to 19mm graded stone under the pipes.
- (d) No compensation shall be made for overbreak and the backfilling thereof except in hard rock conditions where a maximum of 300mm overbreak under the designated trench bottom shall be allowed for. No overbreak shall be allowed for the sides of the trench excavation.

### **PSDB 5.6 BACKFILLING**

#### **PSDB 5.6.1 General**

*Add the following to DB 5.6.1:*

No pipe joint or pipefitting shall be covered by either the blanket fill or main fill prior to the successful completion of the visual inspection of the relevant section of the pipeline.

#### **PSDB 5.6.3 Disposal of soft excavated material**



Contractor



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Witness 2



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Witness 2



All surplus material and all unsuitable material from required excavations shall be disposed of within the pipeline servitude in areas approved by the Project Manager. Dumping shall proceed in an orderly manner with coarse material placed at the bottom and covered with finer material, where possible. Upon completion of dumping the material shall be shaped to provide free-draining surfaces and slopes and finished off to the satisfaction of the Project Manager.

All surplus and unsuitable material from other excavations shall be transported to, dumped and neatly finished off at a municipal dumping site to be identified by the Contractor. The use of the disposal area must be confirmed with the Employer prior to disposal. No payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be included in the tendered rate.

*ADD THE FOLLOWING SUB-CLAUSE:*

**“PSDB 5.11 Excavations through wetlands**

To reduce the impact on wetland soils and hydrology during trenching, the following method shall be followed in conducting pipeline trench excavation crossing the wetland areas:

- i) Wetland boundaries should be clearly marked in work areas to assist the project personnel, contractors and environmental officer to avoid unplanned disturbances to the wetlands. This is also to demarcate the area to which these guidelines apply.
- ii) Where machinery is to be used, the necessary precautionary measures need to be put in place to minimize their impact, especially when this involves driving through the wetland. Where vehicles need to enter the wetland for trenching, the impact can be mitigated by lowering the tyre pressure, thereby distributing the load over a larger area. This more so for wetter wetlands. *The weight of construction vehicles can also be dissipated by creating a wooden platform (thick wooden slats/planks) for vehicles to drive on whilst trenching;*
- iii) Maintain only the minimal footprints for the work necessary to accomplish the task at hand. *This is essential to limiting the impact on the wetlands;*
- iv) Remove the top 30 cm as sods, i.e. the vegetation and underlying soil must be removed as a unit and stored separately from the underlying material. These can be stockpiled immediately next to the trench *(by placing on a material layer - shade cloth or a geotextile. This will ensure that wetland vegetation is not smothered and will negate the need for re-establishment of the wetland vegetation once removed)* if backfilling is to occur within 24 hours and if the local hydrological conditions allow, i.e. there is no surface water on site.
- v) Replace the soil in the reverse order in which it was removed, i.e. the soil that was removed last must be used as the first backfill.
- vi) Ensure that the top 300 mm of the backfill is the topsoil (sod) layer of the material that was excavated from the wetland;
- vii) The backfill must be restored to its pre-construction elevation upon completion of the work. This is to prevent the establishment of preferential flow pathways.
- viii) Ensure that trenching does not create a subsurface drain, i.e. an underground preferential flow path due to i.e. backfilling with soil of lower permeability. This in particular where trenching is to occur in the same direction of the natural flow. Precautions can include inserting clay plugs at approximate 1 m – 2 m intervals; and
- ix) Trenching through a wetland for a pipeline of this diameter should be done to below the impermeable clay layers (the G-horizon). It is this impermeable clay layer that allows for the



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persistence of surface waters to within 500 mm of the surface and, therefore, the existence of the wetland. Trenching to below this layer and then the resealing of this impermeable layer will ensure the retention of proper hydrological functionality of the wetland. It cannot be stressed more that wetland functionality is dependent on the characteristics of the soil stratification within the local area. This stratification must be maintained post construction by placing soils in the reverse order of removal."

## PSDB 7 TESTING

**PSDB 7.1** Insert "and trench bottom" after "backfilling" in the first line.

Insert "5.5 and" before "5.7" in the fourth line.

## PSDB 8 MEASUREMENT AND PAYMENT

### PSDB 8.1 BASIC PRINCIPLES

*ADD THE FOLLOWING:*

Measurement and payment shall distinguish between items that are to be carried out using conventional construction methods and items that are to be carried out using labour-intensive construction methods.

### PSDB 8.3 SCHEDULED ITEMS

#### PSDB 8.3.1 SITE CLEARANCE AND REMOVAL OF TOPSOIL

*ADD THE FOLLOWING SUB-ITEM:*

(d) Remove topsoil in wetlands in accordance with PSDB 5.11 ..... Unit: m<sup>2</sup>

#### PSDB 8.3.2 Excavation:

(a) Excavate in all materials, for trenches, backfill compact and dispose of surplus material

*Replace "of 1,0 m" in the first sentence of DB 8.3.2(a) with :*

*"as specified in the Schedule of Quantities".*

(b) Extra over item (a) above for:

*"Substitute DB 8.3.2(b) with the following:*

**Hard Rock Excavation ..... Unit: m<sup>3</sup>**

Under this contract soft and intermediate excavation shall be classified together as soft excavation, and hard rock and boulder excavation, where boulders are larger than 1 m<sup>3</sup>, shall be classified together as hard rock excavation. Boulders smaller than 1 m<sup>3</sup> shall be classified together with soft excavation.



Contractor



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The disposal of the surplus material will not be measured separately, but will be included in the tendered rate. Payment for this item will only be done, once the finishing of the trenches is to the Engineers satisfaction.

No payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be included in the tendered rate.

Add the following new sub-items to DB 8.3.2:

d) Excavate by hand in soft material to expose existing service ..... Unit : m<sup>3</sup>

e) Excavations and backfill by hand ..... Unit: m<sup>3</sup>

f) Excavate in all materials for trenches in accordance to PSDB5.11 ..... Unit: m<sup>3</sup>

No payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be included in the tendered rate.

### PSDB 8.3.3 Excavation ancillaries

#### PSDB 8.3.3.3 Compaction in Road Reserves

*DELETE THE HEADING AND SUBSTITUTE:*

Compaction in areas subject to road traffic

(a) under roadways to 93% MOD AASHTO ..... Unit : m<sup>3</sup>

(b) elsewhere 93% MOD AASHTO ..... Unit : m<sup>3</sup>

#### PSDB 8.3.3.4 Overhaul

*Replace DB 8.3.3.4 with the following:*

“Notwithstanding any clause in any standardized specification in respect of the definition, no payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Schedule of Quantities.”

### PSDB 8.3.6 Finishing

*ADD THE FOLLOWING SUBCLAUSES:*

**PSDB 8.3.6.2 Reinstatement of topsoil ..... Unit: m<sup>2</sup>**

The rate shall cover the cost of reinstating topsoil as removed to the depth stated in item PSDB 8.3.1 c.

**PSDB 8.3.6.3 Reinstatement of wetland ..... Unit: m<sup>2</sup>**

The rate shall cover the cost of backfilling and reinstating the wetland as stated in PSDB5.11



Contractor



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## PSL: MEDIUM PRESSURE PIPELINES

(Applicable to SANS 1200 L - 1983)

### PSL 3 MATERIALS

#### PSL 3 MATERIAL

##### PSL 3.1 General

*Add the following to L 3.1:*

Each type of pipe delivered to the Site shall have a length corresponding with the lengths specified on the drawings or bill of quantities, with a maximum permissible variation in length of  $\pm 40\text{mm}$ . A pipe that is a shorter or longer than the defined standard will be rejected by the Engineer.

Materials for pipes and fittings to be used for potable water supply shall be non-toxic, shall not support microbial growth and shall not impact taste, odour, turbidity or discoloration to the water after disinfection and washing out of the pipelines.

##### PSL3.4 STEEL PIPES

Steel pipes shall comply with the following particular specifications in **Section C3.6.3**.

PSPM: Manufacture, supply and testing of steel pipes.

PSCL Steel Pipes Coating and Lining

PSPS: Steel Pipe Installation

PSVA: Design, Manufacture and Installation of Valves

### PSL 4 PLANT

#### PSL 4.1 Handling and rigging

*Add the following to L 4.1:*

Pipes and specials shall be protected against damage at all stages from fabrication to delivery. The ends of all pipes and specials shall be protected against denting. The pipes shall be delivered along and as near as possible to the pipeline trench in which they are to be installed.

The Contractor shall unload the pipes from the road vehicle and string them along the trench until they are installed. Some pipes may have to be off-loaded, stacked or obtained from areas some distance from the trench, and the Contractor shall make sufficient allowance in the tendered rates for the transportation and additional handling of the pipes.

Coated pipes shall be moved with the use of sufficiently wide padded slings at least 300mm wide to prevent damage to the coating. Chain slings, hooks, wire ropes, rope slings without canvas covers, belt slings with protruding rivets, and any other equipment that is liable to damaging the coating shall not be used. Spreader beams shall be used for lifting large steel pipes in order to avoid overstressing the pipe and damaging the lining and coating. The



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length of the spreader beam shall be at least two thirds of the length of the pipe to be lifted. Lifting centres for pipes shall not be more than 6m apart.

To ensure that coated pipes do not bear against each other whilst being transported, use shall be made of resilient material such as dunnage that shall not disintegrate or deteriorate when exposed to the elements for prolonged periods.

The pipes shall be stacked with a minimum clearance of 50mm between adjacent pipe walls. The pipes shall be stacked in manner that limits the loading on the lower layer of the pipes. The Engineer shall reject any pipe showing permanent ovality due to surcharge loading. Stacking of smaller diameter pipes within larger diameter pipes will not be accepted pipes, which are lined and coated unless adequate dunnage is provided to prevent damage to the coating, and lining. Any pipe damaged during handling, haulage, storage or installation shall be repaired as specified or shall be replaced at the Contractor's expense.

For all pipes and fittings with factory applied cement mortar linings, the manufacturer shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. Such bulkheads shall be substantial enough to remain intact during transportation and storage until the pipe or fitting is installed.

## **PSL 5 CONSTRUCTION**

### **PSL 5.1 Laying**

#### **PS L 5.1.1 General**

*Add the following to L 5.1.1:*

After the bottom of the trench has been inspected and approved by the Project Manager, a 150mm thick layer of loose selected backfill material shall be placed thereon. Except where it is required that flanged pipes should be supported on pedestals, pipes shall be laid in such a manner that the full length of the pipe bear uniformly on the loose material. After the pipes have been placed in position, the loose material shall be compacted as specified on both sides of the pipes by using hand compaction equipment.

The out of roundness at a plane perpendicular to the pipe axis at any point along the pipeline length shall not exceed 4% of the minimum as laid inside diameter (i.e. + 2% of the nominal internal diameter) after completion of the backfilling and with atmospheric pressure inside the pipe.

Out of roundness being measured as the difference between the minimum and maximum inside diameter of the pipe at a point.

#### **PS L 5.1.2 Damage**

*Add the following to L 5.1.2:*

The work under this project will be carried out in close proximity of existing services. The Contractor shall take note of these existing services and take all necessary precautions while working in the vicinity of these services in order not to damage them. Any damage to existing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

services shall be repaired or replaced immediately by the Contractor to the satisfaction of the Engineer. The cost of any such repairs will be to the account of the Contractor.

### **PS L 5.1.3 Keeping Pipelines clean**

*Add the following to L 5.1.3:*

The interior surfaces of all pipes, specials, valves and fittings shall at all times be kept free from dust, silt, foreign matter and access by rodents, animals and birds shall be prevented. Pipes and specials shall not be used as shelters by staff or for the storage of garments, tools, materials, food containers or similar goods. Particular care shall be exercised at all times to prevent faecal contamination of pipe interiors by staff, casual visitors or passers-by.

Metal night-caps approved by the Project Manager shall be used to close off all ends of each laid section of pipeline when work is stopped at the end of the day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are connected to the rest of the pipeline.

Notwithstanding the use of night-caps the Contractor shall at his own expense, make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter.

The Contractor shall at his own expense and to the satisfaction of the Project Manager, clean the interior of the pipeline of such contaminants, failing which, the Project Manager may order the Contractor to remove the pipes from the trench and replace them with clean pipes at his own cost.

### **PSL 5.2.3 Welding (Steel Pipelines of Diameter 600 mm or greater)**

*Add the following to L 5.2.3:*

The Contractor shall use rubber wheeled trolleys to access the inside of pipelines larger than 500mm ND in order to do inside welding, repair joints and linings as well as inspections. Persons entering pipelines shall wear clean, soft soled footwear. Mechanical fans shall be provided inside pipelines to ensure that an adequate air supply is available for those entering the pipelines. Engine driven fans shall be fitted with a flexible exhaust or other suitable methods of keeping exhaust fumes clear of the fresh air."

### **PSL 5.6 Valve and hydrant chambers**

#### **PSL 5.6.1 General**

*Replace the words "drawing L-1" in the second line with "the Drawings".*

#### **PSL 5.6.2 Construction of chambers**

*Replace the words "drawing L-1, L-2 and L-3" in the fourth line with "the Drawings".*

### **PSL 5.9 Lifting and relaying of existing pipes**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



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*Add the following to L 5.9:*

“Where new pipes, valves or specials are to be connected to, or inserted into existing mains, the Contractor shall excavate back along the existing main only as far as is necessary in order to complete the connection satisfactorily - he shall ensure that suitable material is carefully placed and properly compacted beneath all existing and new work so that the pipes, specials, etc. are properly bedded on sound material.

Where necessary, the Contractor shall cut the existing pipes so that new valves and/or specials can be installed. Care shall be taken that the lengths cut from existing pipes, etc. are accurate so as to ensure a proper joint when the new material is installed. Similarly, where specials and/or valves are removed from existing pipes, closure pieces shall be accurately cut to length and the gaps properly closed.

Where nominal pipe/fitting sizes are specified and/or shown on the drawing, it shall be the responsibility of the Contractor to confirm the accurate sizes of the pipes involved and to supply the new materials according to these measured sizes.”

Where shown on the drawings or where so instructed by the Project Manager, the Contractor shall excavate, expose and remove from the ground, existing water pipelines.

If so instructed by the Project Manager, the Contractor shall, before commencing with the excavation of the pipeline, expose the pipeline to be removed by means of careful hand excavation at positions agreed with the Project Manager, in accordance with the requirements of Sub-clause PSA 5.4.1.

Thereafter, the existing pipelines to be removed shall be carefully opened up by machine excavation to a depth of not more than 300 mm above the pipes after which the whole pipeline shall be fully exposed by means of careful hand excavation. The excavation width shall comply with Sub-clause 5.2 or as shown on drawings.

The pipes and all specials encountered (eg. bends, valves, valve box covers and the like) shall be removed from the trench in a manner as to avoid causing damage and as approved by the Project Manager, cleaned sufficiently as to allow inspection of the pipes and specials by the Project Manager and stacked in such a manner as will facilitate the inspection of each pipe and special by the Project Manager. The pipes and specials shall be clearly marked to show the position from which they were removed.

Pipes and specials removed shall be transported to the Lepelle Northern Water's storeyard located at PS2 Pump Station in Lebowakgomo, where they shall off-loaded and neatly stacked to the satisfaction of the Engineer. The Contractor shall be responsible for obtaining a written receipt of all pipes so delivered to the Employer's storeyard.

Pipes and specials which are declared by the Engineer as unsuitable for re-use shall be transported to a spoil site and covered with spoil material to a depth of not less than 300 mm.

*Add the following new clauses to L 5:*

**PSL5.11 Pipeline route markers**

Pipeline markers shall be installed at the following positions:

- Horizontal bends;
- Servitude boundaries of provincial roads and railway lines;



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Between horizontal bends and valve chambers where distances in between exceed 300m.

#### **“PSL5.12 CONNECTION TO EXISTING PIPEWORK**

Following the Engineer’s approval the contractor shall make all necessary arrangement with Employer for temporary shutdown of the relevant sections of water supply infrastructure well in advance of the intended date. The contractor shall ensure that all the necessary spares of material standby equipment and lighting as identified in terms of approved methodology are available on site 24 hours prior to commencement of shut down and isolation work. The contractor shall make provision for adequately staffed construction team comprising of day and night shift. The shut down period may not exceed 48 hours including allowance for required time to drain and fill-up of pipeline”.

#### **PSL7 TESTING**

##### **PSL 7.1 General**

*Replace the first sentence of L 7.1 with:*

Pipes shall be pressure tested in convenient lengths not exceeding 1 000 m. Longer test lengths require the Project Manager's approval.

*Add the following to L 7.1:*

The Contractor must include in his rates for all equipment, anchor or thrust block arrangements and overhead costs necessary for testing.

##### **PSL 7.3 Standard hydraulic pipe test**

##### **PSL 7.3.1 Test pressure and time of test**

**PSL 7.3.1.2** Testing pressure shall be 1.5 times Working Pressure as scheduled or labelled by the manufacturer.

Hydraulic pipe tests shall be carried out in the presence of both the Engineer and the Contractor, and for each test a form shall be completed and certified by both parties, as a record of the test.

#### **PSL 8 MEASUREMENT AND PAYMENT**

**PSL 8.2.1 Supply, Lay and Bed pipes complete with Couplings..... Unit : m**

*ADD THE FOLLOWING:*

The price tendered and paid for pipelines of various diameters and types shall include for the supply and installation of all fittings, joints and specials not specifically scheduled.

Payments of pipes laid shall be affected as follows:

- 90% of the laid rate on successful completion of laying, cutting, jointing and flushing of the line plus selected fill.
- 100% on successful completion of the hydraulic testing of the line.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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Pipe work is to be bedded as indicated on the drawings of in the schedule of quantities.

**PSL 8.2.11 Anchor blocks / thrust blocks and pedestals**

*Insert "concrete" before "and" in the last line of the last paragraph of L 8.2.11.*

**PSL8.2.13 Valve and Hydrant Chambers, etc**

*ADD THE FOLLOWING:*

The rate for construction of valve chambers shall be inclusive of excavation, supply of all materials including concrete, reinforcement air vents, access ladders, as shown on the Drawings for the chamber type and specified depth.

**PSLB: BEDDING (PIPES)**

(Applicable to SANS 1200 LB - 1983)

**PSLB 3 MATERIALS**

**PSLB 3.2 SELECTED FILL MATERIAL**

*ADD THE FOLLOWING:*

Selected fill material used for bedding shall be stabilised with 5% cement as specified under Sub-clause PSDB 3.5(d).

**PSLB 3.4 SELECTION**

**PSLB 3.4.1 Suitable material available from trench excavation**

*REPLACE THE WORDS "(but is not required)" IN THE FIFTH LINE WITH THE WORDS "(at his own cost)".*

**PSLB 8 MEASUREMENT AND PAYMENT**

**PSLB 8.1 PRINCIPLES**

**PSLB 8.1.5 Disposal of displaced material**

*REPLACE THE CONTENTS OF THIS SUB-CLAUSE WITH THE FOLLOWING:*

"Material displaced by the pipeline and by imported material from sources other than trench excavation, shall be disposed of at an approved site furnished by the Contractor. No haulage is payable for such material."

**PSLB 8.1.6 Free-haul**

*REPLACE THE CONTENTS OF THIS ITEM WITH THE FOLLOWING:*



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

“Notwithstanding any clause in any standardized specification in respect of the definition, no payment will be made for overhaul and all transport shall be regarded as freehaul and the costs thereof shall be covered by the relevant tendered rates in the Schedule of Quantities.”

## PSLB 8.2 SCHEDULED ITEMS

ADD THE FOLLOWING ITEM:

**PSLB 8.2.6** Extra over items 8.2.1 and 8.2.2 for bedding stabilised  
with 5% cement .....Unit : m<sup>3</sup>

## C3.6.3 PARTICULAR SPECIFICATIONS

|       |                                                          |
|-------|----------------------------------------------------------|
| PSPM  | Manufacture of Steel Pipes                               |
| PSCL  | Steel Pipes Coating and Lining                           |
| PSPS  | Steel Pipelines Installation                             |
| PSVA  | Design, Manufacture and Installation of Valves           |
| PSM&E | Mechanical, Electrical and C&I Refurbishment and Upgrade |
| CP    | Technical Specifications for Cathodic Protection         |

## PARTICULAR SPECIFICATION: PSPM

### DESIGN, MANUFACTURE AND SUPPLY OF STEEL PIPES AND FITTINGS

#### PSPM-1 SCOPE

This specification covers the design, manufacture and supply of bare electric welded low carbon steel pipes and fittings for the conveyance of water at ambient temperatures and at medium pressures.

#### PSPM-2 SUPPORTING SPECIFICATIONS

|           |                                                                     |
|-----------|---------------------------------------------------------------------|
| SANS 1200 |                                                                     |
| SANS 62   | Steel Pipes and Fittings up to 150mm NB                             |
| SANS 719  | Electric welded low carbon Steel Pipes for aqueous fluids.          |
| SANS 044  | Welding                                                             |
| BS 5354   | Steel Pipes and Specials for water and sewage                       |
| BS 2633   | Class 1 arc welding of ferritic steel pipework for carrying fluids. |
| API 5L    | Line Pipe                                                           |
| API 1104  | Standard for welding pipelines and related facilities.              |

#### PSPM-3 APPLICATION



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

This specification contains clauses that are generally acceptable to the design, manufacture and supply of steel pipes, fittings, and specials for pressures up to 3 MPa. The pipe and specials diameter range from 200Ø to 800Ø to be manufactured from Steel Grade X42.

#### **PSPM-4 MATERIALS**

Material requirements shall conform to the relevant clauses of SANS 719 being:

- Steel Plate and Strip
- Chemical Composition
- Physical Properties
- Certification

#### **PSPM-5 MATERIAL THICKNESS**

Wall thickness shall be as per Table 2 as per SANS 719.

#### **PSPM-6 DIMENSIONAL REQUIREMENTS**

Length of standard lengths to be proposed by the Contractor for approval by the Engineer. Other clauses in SANS 7.9 include:

- General
- Random Lengths
- Exact Lengths
- Dimensions
- Table 2 - Preferred nominal bores, outside diameters and wall thickness of pipe.

#### **PSPM-7 WELDING PROCEDURES**

The Contractors welding procedures to be reviewed and approved by the Engineer.

#### **PSPM-8 WELD HEIGHTS**

Internal Pipe - 1,0mm max External Pipe - 2,0mm max

#### **PSPM-9 STRAIGHTNESS OF PIPE**

The deviation of a pipe from a straight line shall not exceed 0,2% of the length of the pipe.

#### **PSPM-10 PIPE ENDS**

Pipe ends shall be clean cut, free from burrs and square to the axis of the pipe. Ends prepared for field welding shall be prepared as follows:

Bevel 30 deg + 5 deg

Root face 1,6mm (Min 1,0mm, Max 2mm)

Maximum deviation from squareness to the axis 1,5mm for pipes up to 500mm NB Maximum deviation from squareness to the axis 3,0mm for pipes above 500mm NB

#### **PSPM-11 OUT OF ROUNDNESS / OVALITY**

Using any acceptable method to determine the actual minimum and maximum values of the outside diameter (i.e., the measured values corrected when relevant for sag).

Establish that these values do not vary from the nominal diameter by more than 1% or 6mm.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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## **PSPM-12 NON- DESTRUCTIVE TESTING**

Pipes up to 610mm O/D (ERW)

Ultra-Sonic inspection shall be performed on 100% of all longitudinal welds Spirally welded pipes

Ultra-Sonic inspections to be performed on 100% of welds. Radiographic Examinations to be performed on all H or Skelp welds OR

Radiographic inspections / examinations (Fluoroscope) to be performed on all spiral welds.

## **PSPM-13 WELD REPAIRS**

The Contractor to submit a repair procedure for approval by the Engineer. All repair welds to be tested Radiographically.

## **PSPM-14 HYDROSTATIC TESTING**

Pipes shall be capable of withstanding, without leaking or bursting at testing of 7 Lpa unless agreed otherwise by the purchaser / Engineer.

## **PSPM-15 DESTRUCTIVE TESTS**

### **15.1 Transverse tensile test**

From a cold flattened section of pipe, a test specimen shall be cut as per figure 2 of SANS 719. Do not remove weld reinforcement. Determine the ultimate tensile strength (UTS) by the method in SANS 6892-1.

### **15.2 Root Bend Test (ERW)**

From a cold flattened or as cut section of pipe cut a specimen conforming to figure three of SANS 719. Remove the weld reinforcement and file the arises to a radius no exceeding 10% of the thickness of the specimen. Bend through an angle of at least 180 deg. Check for compliance in ref to SANS 719 5.2.2.2.11.

### **15.3 Flattening Test**

Cut a cylindrical test specimen as per figure four of SAN 719. Ensuring that the weld is at the point of maximum bending flatten the specimen between two parallel surfaces until the outside diameter to which the compression is applied is reduced to not more than two thirds of its original value. No cracks shall be visible on the outer surface.

## **PSPM-16 QUALITY CONTROL PLAN**

Prior to commencement of pipe manufacture the contractor shall submit a Quality Control Plan in respect of the specification. The Quality Control Plan to be reviewed by the Engineer and intervention points noted.

## **PSPM-17 ENGINEERS INSPECTION**

Engineers' inspections will be performed in accordance with the agreed intervention points of the Quality Control Plan.

## **PSPM-18 STEEL PIPE FITTINGS**

### **18.1 Quality Control Plans**

Prior to the commencement of fabrication, Quality Control Plans shall be submitted for review and approval by the Engineer. Prior to the commencement of fabrication, corrosion protection Quality Control Plans shall be submitted for review and approval by the Engineer.

### **18.2 Welding Procedures**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



Prior to commencement of welding, Welding Procedures shall be submitted for review and approval by the Engineer.

### 18.3 Approved Drawings

Prior to the commencement of fabrication all drawings / shop drawings shall be submitted to the Engineer for review and approval.

### 18.4 Materials

Material Certificates for all pipes and flanges to be compiled in the manufacturing data book.

### 18.5 Pipe Wall Thickness

The wall thickness of the pipe shall be subject to tolerance of + 10% or - 8% of the actual specified or required thickness.

### 18.6 Pipe End Preparation for Butt Welding

Pipe ends to be clean cut, free from burrs and acceptably square to axis. Pipe ends prepared for butt welding shall be bevelled 30 deg + 5 deg. A root face of 1mm min 2mm max is required.

### 18.7 Pipe end Squareness

Squareness of the axis of the pipe shall not deviate from the following:

- Pipes not exceeding 500mm NB - 1,5mm
- Pipes exceeding 500mm Nb - 3mm

### 18.8 Welding

All circumferential and longitudinal welds shall be subject to 100% Radiographic examinations (API 1104).

All flange and fillet welds shall be subjected to 100% Liquid Penetration Testing (API 1104).

### 18.9 Weld Repairs

Should a repair be noted after Radiographic or Liquid Penetrant Testing the weld can be repaired as a repair one status providing the same welding process is used for the repair. Should a weld repaired fail examination it will be considered a repair two status which will require a separate WPS for such repair status. Welds failing examination at repair status two will be considered as a cut out and re-weld status.

### 18.10 Weld Height

Internal weld height - 1mm max

External weld height - 2mm max

## PSPM-19 DIMENSIONS

Dimensions of fittings to comply with approved shop drawings and BS 534.

## PSPM-20 FLANGES

Flanges to comply with requirements of SANS 1123 up to 1200mm NB. Flanges with pressure rating up to 1600 kPa will have flat faced joint faces. Flanges with pressure rating 2500 and 4000 kPa shall have raised faces.

Flanges falling beyond the range of SANS 1123 shall be in accordance with ISO Standard 7005.

## PSPM-21 CONTRACTORS MANUFACTURING DATA BOOK



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall maintain a data book throughout the process of manufacture. The content / index of the data book shall be submitted to the Engineer for approval. Items presented for final inspections will have data reviewed prior to release.

## **PSPM-22 ENGINEERS INSPECTIONS**

The Engineers inspections will be performed as per the relevant interventions as noted on the agreed Quality Control Plans.

## **PARTICULAR SPECIFICATIONS: PSCL**

### **STEEL PIPES COATING AND LINING**

#### **INDEX**

- PSCL-1: Rigid Polyurethane ( RPU )
- PSCL-2: Three Layer High Density Polyethylene ( 3LPE )
- PSCL-3: Fusion Bonded Medium Density Polyethylene (FBMDPE )
- PSCL-4: Polymer Modified Bitumen ( Bituguard )
- PSCL-5: Two Layer GRE Line Pipe ( Stopaq )
- PSCL-6: Solvent Free Epoxy

## **PSCL1: RIGID POLYURETHANE COATING SYSTEM**

### **PSCL-1.1 MATERIAL**

The required external coating shall be a two-component liquid applied polyurethane.

### **PSCL-1.2 COATING SYSTEM PRE - QUALIFICATION**

The coating system shall be identified in the Contractors bid with name and product number. The following certified test reports are required to be submitted:

- a) Name of Manufacturer
- b) Name, use and type of product
- c) Type of Polyol
- d) Type of Isocyanate
- e) Factory of origin
- f) Batch or production lot number
- g) Pot life
- h) Curing times
- i) Time at 23 deg +/- 2 deg to achieve shore "D" hardness (ASTM D2240) at cu
- j) Composition (FTR fingerprint)

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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k) Resistance to abrasion

### PSCL-1.3 PROCEDURE QUALIFICATION TRIAL (PQT)

The Contractor shall perform a Procedure Qualification Trial (PQT) prior to production coating. The qualification testing shall verify the following properties:

- a) Minimum average Dry Film Thickness (1.7 mm) SANS 2808
- b) Shore "D" Hardness (ISO 868)
- c) Cut Back - 100mm +/- 20mm
- d) Holiday Detection- no defects SANS 1217
- e) Impact Resistance - 0,6 kgm (ASTM D 2794 f) Pull off Adhesion- (7MPa) SANS 776
- g) Cathodic Disbondment 28 day - (18mm ECD) ASTM G 8
- h) Dielectric Strength - (15kV /mm) ASTM D 149
- i) Flexibility - ASTM D 522a: 1993
- j) Elongation - (10%) ISO 527
- k) Resistance to Abrasion - (0.08g) ASTM D 4060

### PSCL-1.4 QUALITY CONTROL PLAN

Prior to production coating, a Quality Control Plan shall be submitted to the Engineer for approval. The Quality Control Plan shall be sufficiently detailed to indicate for each discipline the required quality control, inspection and testing referring to relevant procedures.

### PSCL- 1.5 SURFACE PREPARATION

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m2 equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.

### PSCL- 1. 6VISUAL EXAMINATION OF BLAST CLEANED SURFACES

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### PSCL- 1.7 ELAPSED TIME PRIOR TO COATING

The elapsed time between completion of surface preparation and coating application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |

### PSCL -1.8 COATING APPLICATION

The coating application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. Heating shall be by heating coils, radiant heaters or hot air to the temperatures approved by the coating manufacturer.

The use of propane torches / gas burners is not recommended. Temperatures to be measured by temperature indicating crayon or infrared / surface temperature gauges. The application of coating shall be as the manufacturers data sheet.

### PSCL- 1.9 COATING APPLICATION VISUAL

The coating shall be uniform and free of runs, sagging or lamination

### .PSCL- 1.10 COATING THICKNESS

| Coating Thickness Required |                                                 |
|----------------------------|-------------------------------------------------|
| Mean (Average)             | 1.7 mm                                          |
| Minimum                    | 1.4 mm (No single measurement less than 1,4 mm) |
| Maximum                    | 2 mm                                            |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## **PSCL- 1.11 ELECTRICAL INSULATION DEFECT TESTING**

EID / High Voltage Holiday Detection to be performed at 5kV per 100 microns.

## **PSCL- 1.12 ENGINEERS INSPECTION**

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

## **PSCL-2: THREE LAYER HIGH DENSITY POLYETHYLENE (3LPL) COATING SYSTEM**

### **PSCL-2.1 MATERIAL**

The required external Coating shall be a three layer high density Polyethylene system comprising of:

- Fusion Bonded Epoxy layer
- Adhesive layer
- High Density Polyethylene layer

### **PSCL-2.2 COATING SYSTEM CERTIFICATION REQUIRED**

#### **FBE**

- Gel and cure times
- Particle size distribution
- Density
- Moisture content
- Infrared scan
- Thermal analysis
- Water absorption
- Shelf life

#### **Adhesive**

- Adhesion
- Density
- Tensile Strength
- Elongation
- Melt flow index

#### **Polyethylene**

- Density
- Melt flow index
- Melting point
- Shore Hardness
- Elongation
- Tensile Strength
- Moisture Content
- Carbon black content



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Carbon black dispersion

A 1 kg sample of each of each material and batch should be stored in containers at recommended temperature and be available for a period of two years after applications.

### PSCL-2.3 PROCEDURE QUALIFICATION TRIAL (PQT)

The Contractor shall perform a Procedure Qualification Trial (PQT) prior to production coating. For the PQT the contractor shall prepare one pipe with FBE coating only and two fully coated pipes unless other preparations are approved by the Engineer.

#### Requirements of PQT:

| Degreasing                                     |                                                                          |
|------------------------------------------------|--------------------------------------------------------------------------|
| Chloride Test                                  | ISO 8502                                                                 |
| Abrasive Blasting                              | ISO 8051 - Part 1 - Class Sa3                                            |
| Profile                                        | ISO 8503 - Part 5 - 50 to 100 microns                                    |
| Degree of Cleanliness                          | ISO 8502-3 - less than 2                                                 |
| Acid Wash                                      |                                                                          |
| FBE Application                                | 325 microns +/- 75 microns                                               |
| Adhesive layer                                 | 250 microns                                                              |
| FBE + Adhesive layer                           | 600 microns +/- 150 microns                                              |
| Polyethylene Application                       | 3,0mm to achieve total thickness of 3,5mm for pipes above 600mm diameter |
| Visual Inspection                              |                                                                          |
| Total cut back                                 | 150mm                                                                    |
| FBE Toe                                        | 50mm +/- 10mm                                                            |
| Holiday Test (FBE only)                        | 5v p/micron                                                              |
| Holiday Test (comp coating)                    | 5v p/micron to max 15 kV                                                 |
| Air Entrapment                                 | App B - CAN/CSA-Z245.20                                                  |
| Adhesion -Peel Test 20 deg c                   | DIN 30670                                                                |
| Adhesion - Peel Test 50 deg C                  | DIN 30670                                                                |
| Adhesion - Peel Test 80 deg C                  | ISO 21809-1                                                              |
| Degree of Cure - FBE only                      | CAN/CSA Z245.20 - 12.7.3                                                 |
| Cathodic Disbondment 20 +/- 3 deg 1,5v 28 days | CAN/CSA-Z245.20 - 21                                                     |
| Water Absorption Test (FBE)                    | Test Method to be submitted                                              |
| Hot Water Resistance                           | Test Method to be submitted                                              |
| Resistance to indentation                      | ISO 21809-1                                                              |
| Impact resistance (FBE)                        | CAN/CSA Z245-20-02                                                       |
| Impact resistance (PE)                         | ISO 21809-1                                                              |
| Elongation (PE)                                | DIN 30670                                                                |
| Flexibility Bend Test (FBE)                    | Test Method to be submitted                                              |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



#### PSCL-2.4 QUALITY CONTROL PLAN

Prior to production coating, a Quality Control Plan shall be submitted to the Engineer for approval. The Quality Control Plan shall be sufficiently detailed to indicate for each discipline the required quality control, inspection and testing referring to relevant procedures.

#### PSCL-2.5 SURFACE PREPARATION

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m<sup>2</sup> equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.

#### PSCL-2.6 VISUAL EXAMINATION OF BLAST CLEANED SURFACES

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting.

#### PSCL-2.7 ELAPSED TIME PRIOR TO COATING

The elapsed time between completion of surface preparation and coating application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |

#### PSCL-2.8 COATING APPLICATION

The coating application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. The application of coating shall be as the manufacturers data sheet.

##### FBE Layer

- FBE to be applied to a minimum average thickness of 325 microns
- The pipe shall be uniformly heated



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Surface temperature not to exceed 260 deg c.
- Temperature to be measured with approved / calibrated equipment.

**Adhesive Layer**

- Adhesive layer application to be applied to a minimum average thickness of 250 microns
- Adhesive layer to be applied prior to FBE before gel time of the FBE has expired.

**Polyethylene Layer**

The Polyethylene layer to be applied to ensure that the total thickness of the 3LPE (FBE + Adhesive + Polyurethane) is min 3.5mm for pipes over 600mm dia.

**PSCL-2.9 COATING THICKNESS**

Total Coating thickness to be minimum of 3,5 mm for pipes greater than 600mm diameter.

**PSCL-2.10 COATING CUT BACK**

Polyethylene cut back +/- 120mm. Pipe ends shall be supplied as bare steel free of all coating for a distance of 100mm (+25mm / - 0mm) from the pipe end.

In addition, each pipe shall be left without Polyethylene / Adhesive coating leaving a 20mm exposed FBE toe. The ends of the Polyethylene coating to be bevelled between 35 and 45 degrees.

**PSCL-2.11 ELECTRICAL INSULATION DEFECT TESTING**

EID / High Voltage Holiday Detection to be performed at 5kV per 100 microns. Maximum 15 kV setting.

**PSCL-2.12 ENGINEERS INSPECTION**

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

**PSCL-3: MDPE COATING SYSTEM (XTALENE)**

**PSCL-3.1 MATERIALS**

The required external Coating shall be a Fusion Bonded Medium Density Polyethylene in accordance with AS 4321 Second Edition 2001.

**PSCL-3.2 COATING SYSTEM CERTIFICATION REQUIRED**

Batch Certificates

Materials in terms of AS 4232 points 4.1 to 4.3.2



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### PSCL-3.3 PROCEDURE QUALIFICATION TRIAL (PQT)

The Contractor shall perform a Procedure Qualification Trial (PQT) prior to production coating.

#### **Requirements of PQT:**

| <b>Degreasing</b>                     |                                       |
|---------------------------------------|---------------------------------------|
| Chloride Test                         | ISO 8502                              |
| Abrasive Blasting                     | ISO 8051 - Part 1 - Class Sa3         |
| Profile                               | ISO 8503 - Part 5 - 50 to 100 microns |
| Degree of Cleanliness                 | ISO 8502-3 - less than 2              |
| <b>Visual Inspection</b>              |                                       |
| Total cut back                        | 100mm                                 |
| Holiday Test                          | 5v p/micron                           |
| Thermal Stability                     | AS4321- 6.1.2.2                       |
| Water Absorption                      | AS4321- 6.1.2.3                       |
| Penetration Resistance                | AS4321- 6.1.2.4                       |
| Tensile Stress at Yield               | AS4321- 6.1.2.5                       |
| Environmental Stress Crack Resistance | AS4321- 6.1.2.6                       |
| Density                               | AS1193 (ISO 1183)                     |

### PSCL-3.4 QUALITY CONTROL PLAN

Prior to production coating, a Quality Control Plan shall be submitted to the Engineer for approval. The Quality Control Plan shall be sufficiently detailed to indicate for each discipline the required quality control, inspection and testing referring to relevant procedures.

### PSCL-3.5 SURFACE PREPARATION

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m2 equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### PSCL-3.6 VISUAL EXAMINATION OF BLAST CLEANED SURFACES

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting.

### PSCL-3.7 ELAPSED TIME PRIOR TO COATING

The elapsed time between completion of surface preparation and coating application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |

### PSCL-3.8 COATING APPLICATION

The coating application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. The application of coating shall be as the manufacturers data sheet.

### PSCL-3.9 COATING THICKNESS

| Reference to Table 1 AS 43211 |        |
|-------------------------------|--------|
| Less than 273mm o/d           | 1,6 mm |
| 273mm to 508mm o/d            | 1,8 mm |
| 508mm to 762mm o/d            | 2,0 mm |
| Greater than 762mm o/d        | 2,3 mm |

### PSCL-3.10 COATING VISUAL

The Coating shall be glossy, free from pinholes, excessive orange peel, bubbling or excessive runs or sags.

### PSCL-3.11 COATING CUT BACK

MDPE cut back 120mm +/- 20mm

### PSCL-3.12 ELECTRICAL INSULATION DEFECT TESTING

EID / High Voltage Holiday Detection to be performed at 5v per micron. Maximum 15 kV setting.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### PSCL-3.13 REPAIR LIMITS FOR FB

Reference is made to AS 4321- 2001 7.2 to 8.1. The Contractor shall provide method statements for the various categories of repair for approval by the Engineer.

### PSCL-3.14 ENGINEERS INSPECTION

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

## PSCL-4: POLYMER MODIFIED BITUMEN COATING SYSTEM (BITUGUARD)

### PSCL-4.1 STANDARDS

|                 |                                                                                                                                                                          |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BS 410          | Specification for test sieves                                                                                                                                            |
| BS 1796         | Methods using test sieves of woven wire cloth and perforated metal plate                                                                                                 |
| BS 2000         | Method of test for petroleum and its products                                                                                                                            |
| BS 3900         | Methods of tests for paints<br>Part A 6 (EN 535) determination of flow time if paints<br>Part B2 (ISO / DR 1515) Determination of volatile matter / non- volatile matter |
| BS EN 10300     | Steel tubes and fittings for onshore and offshore pipelines<br>Bitumus hot applied materials for external coating                                                        |
| BS 7079         | (ISO 8501 - 8504) Preparation of steel substrates before application of paints or related products.                                                                      |
| ISO 8501        | Pictorial surface preparation standards for the painting of steel surfaces.                                                                                              |
| ATM D 113-86    | Ductility of bituminous materials                                                                                                                                        |
| ANSIII AWWAC203 | Coal Tar Protective Coatings and linings for steel water pipelines- enamel and tape hot applied                                                                          |
| SANS Method 772 | Blast profile                                                                                                                                                            |

### PSCL-4.2 PRIMER

The primer shall be of a synthetic composition, designed to be used with a specific polymer modified bitumen. The drying rate of the primer shall be suited to the application conditions. The primer to be supplied in new sealed drums.

Characteristics of primer shall have the following:

| Characteristic    | Requirements            | Method of Test |
|-------------------|-------------------------|----------------|
| Viscosity at 23°C | 35 - 60 seconds         | Flow Cup No 4  |
| Volatile Matter   | 75 (Max % loss by mass) | BS3900 Part A6 |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

#### PSCL-4.3 POLYMER MODIFIED BITUMEN

A formulated blend of polymer bitumen as per data sheet provided. Limestone or asbestos not permitted.

#### PSCL-4.4 FILLER GRADINGS

- Method of test to BS 1796 modified to use the metric sieves specified in BS 410
- Passing 90 microns - not less than 93%
- Passing 250 microns - not less than 99%

#### PSCL-4.5 PROCEDURE QUALIFICATION TRIAL (PQT)

The Contractor shall perform a Procedure Qualification Trial (PQT) prior to production coating.

##### **Requirements of PQT:**

| Degreasing            |                                       |
|-----------------------|---------------------------------------|
| Chloride Test         | ISO 8502                              |
| Abrasive Blasting     | ISO 8051 - Part 1 - Class Sa3         |
| Profile               | ISO 8503 - Part 5 - 50 to 100 microns |
| Degree of Cleanliness | ISO 8502-3 - less than 2              |
| Visual Inspection     |                                       |
| Total cut back        | 100mm                                 |
| Holiday Test          | 5v p/micron                           |
| Softening Point       | ASTM D36                              |
| Penetration @ 25°C    | ASTM D5                               |
| Density @ 25 °C       | BS 4147                               |
| Viscosity at 170° C   | Brookfield                            |
| Viscosity at 190° C   | Brookfield                            |
| Filler Content        | BS 4147                               |
| Impact @ - 10°C       | BS 4147                               |
| Peel Test @ 25°C      | 3.0 / 3.0                             |
| Peel Test @ 40°C      | 3.0 / 3.0                             |
| Sag 80°C              | BS 4147                               |
| Ageing Test           | Phoenix                               |
| Bend Test             | BS 4147                               |

Test plates shall be cleaned to abrasive blasting to grade Sa 3. (SANS Method 772).

Impact test requires a plate of 12.7mm thick and a single impact on each quarter of the plate.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



#### **PSCL-4.6 COATING APPLICATION**

The coating application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. The application of coating shall be as the manufacturers data sheet.

#### **PSCL-4.7 SURFACE PREPARATION**

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m2 equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.

#### **PSCL-4.8 VISUAL EXAMINATION OF BLAST CLEANED SURFACES**

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting

#### **PSCL-4.9 ELAPSED TIME PRIOR TO COATING**

The elapsed time between completion of surface preparation and coating application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |

#### **PSCL-4.10 PRIMING**

Within 4 hrs of grit blasting primer shall be applied as per manufactures recommendations. The primer shall be applied to a dry, clean and dust free surface and thereafter shall be kept free from moisture and other contaminants. Primer to be applied at a temperature of + 15°C.

#### **PSCL-4.11 EXTERNAL COATING APPLICATION**

After priming the coating shall be applied through coating facilities approved by the coating supplier. The facility shall coat the pipe including log or spiral weld with a 50 mm wide strip of polymer modified bitumen.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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#### **PSCL-4.12 COATING THICKNESS**

The coating thickness including outer wrap shall have an average thickness of not less than 5,5mm. Particular coating thickness of 5mm above spiral weld is required.

#### **PSCL-4.13 COATING CUT BACK**

PMB cut back 120 mm +/- 20 mm

#### **PSCL-4.14 ELECTRICAL INSULATION DEFECT TESTING**

EID / High Voltage Holiday Detection to be performed at 5v per micron. Maximum 15 kV setting.

#### **PSCL-4.15 REPAIR LIMITS FOR PMB**

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation of the pipes or pipe installation may occur. A repair method statement to be forwarded by the Contractor for Engineers approval.

#### **PSCL-4.16 ENGINEERS INSPECTION**

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

### **PSCL-5: TWO LAYER GRE COATING SYSTEM (Stopaq or Similar)**

#### **PSCL-5.1 MATERIAL**

Corrosion preventing primary coating consisting of a cold applied, non-cross linked, non-crystalline, monolithic viscous pure polyisobuten polymer based, prefabricated wrap coating with cold flow, self-healing, visco elastic properties. Mechanical protective outer layer consisting of layers of Glass Fiber Reinforced Epoxy coating.

#### **PSCL-5.2 COATING SYSTEM PRE - QUALIFICATION**

- Name of Manufacturer
- Name, use and type of product
- Factory of origin
- Batch certificates
- Material certificates

#### **PSCL-5.3 PROCEDURE QUALIFICATION TRIAL**

- Minimum average thickness of primary coating (0,85mm)
- Minimum average thickness of GRE (1,0mm)
- Impact resistance at min 15 Joule
- Adhesion to substrate – ISO2109:3 2016 Annex H
- Peel Test – Cohesive separation – ISO 21809:3
- Cathodic Disbondment Test (ASM G95,2 G42)
- Indentation Resistance (EN 12068 Annex G)

#### **PSCL-5.4 QUALITY CONTROL PLAN**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Prior to production coating, a Quality Control Plan shall be submitted to the Engineer for approval. The Quality Control Plan shall be sufficiently detailed to indicate for each discipline the required quality control, inspection and testing referring to relevant procedures.

#### **PSCL- 5.5 SURFACE PREPARATION**

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m2 equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.

#### **PSCL- 5.6 VISUAL EXAMINATION OF BLAST CLEANED SURFACES**

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting.

#### **PSCL- 5.7 ELAPSED TIME PRIOR TO COATING**

The elapsed time between completion of surface preparation and coating application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |

#### **PSCL -5.8 COATING APPLICATION**

The coating application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. Heating shall be by heating coils, radiant heaters or hot air to the temperatures approved by the coating manufacturer.

The use of propane torches / gas burners is not recommended. Temperatures to be measured by temperature indicating crayon or infrared / surface temperature gauges. The application of coating shall be as the manufacturers data sheet.

#### **PSCL- 5.9 COATING APPLICATION VISUAL**

The coating shall be uniform and free of runs, sagging or lamination.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

## PSCL- 5.10 COATING THICKNESS

| Coating Thickness required |                      |
|----------------------------|----------------------|
| Mean (Average)             | 1.85 mm              |
| Minimum                    | 1.85 mm              |
| Maximum                    | Not Recorded / Known |

## PSCL- 5.11 ELECTRICAL INSULATION DEFECT TESTING

EID / High Voltage Holiday Detection to be performed at 10kV.

## PSCL- 5.12 ENGINEERS INSPECTION

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

## PSCL-6: SOLVENT FREE EPOXY – LINING AND COATING

### PSCL-6.1 MATERIAL

Materials shall be as noted in SANS 1217 Type 1B Point 2.

### PSCL-6.2 COATING SYSTEM PRE - QUALIFICATION

The lining system shall be identified in the Contractors bid with name and product number. The following certified test reports are required to be submitted:

- Name of Manufacturer
- Name, use and type of product
- Factory of origin
- Batch or production lot number
- Pot life
- Curing times

### PSCL-6.3 PROCEDURE QUALIFICATION TRIAL (PQT)

The Contractor shall perform a Procedure Qualification Trial (PQT) prior to production coating. The qualification testing shall verify the following properties:

|                                             |                            |
|---------------------------------------------|----------------------------|
| Sample or Pipe Number /Plate Number         |                            |
| Batch Number Details of Surface Preparation | Certificate                |
| Details of Surface Preparation              | SANS 12994-4               |
| Date and time of application                | Record                     |
| Dry Film Thickness Testing                  | SANS 4.2.4                 |
| EID Testing                                 | SANS 4.2.6                 |
| Adhesion Testing                            | SANS Table 1 - ASTM D 4541 |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

|                                                           |                            |
|-----------------------------------------------------------|----------------------------|
| Impact Resistance                                         | SANS Table 1 - ASTM D 2794 |
| Resistance to water Immersion in water at 50°C for 7 days | SANS 5.7                   |
| Dielectric Strength                                       | SANS 5.9                   |
| Resistance to abrasion                                    | ASTM D 4060                |
| Cathodic Disbondment 28 day period at 23° C               | ASTM G 8 ASTM D 4060       |
| Flexibility of material                                   | 13.1.1 Of ASTM D 522A      |

#### PSCL-6.4 QUALITY CONTROL PLAN

Prior to production lining, a Quality Control Plan shall be submitted to the Engineer for approval. The Quality Control Plan shall be sufficiently detailed to indicate for each discipline the required quality control, inspection and testing referring to relevant procedures.

#### PSCL-6.5 SURFACE PREPARATION

Prior to grit blasting surfaces to be inspected for oil and grease contamination. Any oil / grease shall be removed by solvent cleaning using water dispersible cleaners. Salt Tests to be performed once per shift in accordance with the requirements of ISO 8502-6 of less than 20mg/m2 equivalent salt mix.

No grit blasting to be undertaken unless the relative humidity is less than 85% and surface temperature is above 3 deg centigrade above the dew point. The Air temperature, humidity, and pipe temperature to be measured at regular intervals during production shift. Grit Blasting shall only be dry blasting techniques.

A surface profile of 50 microns minimum and 100 microns maximum is required. Any loose dust debris to be removed by use of compressed air, brush, or vacuum cleaner. The blasted surface shall be checked for dust contamination in accordance with SANS Method 769 Dust and Debris with a dust rating of less than 2.

#### PSCL-6.6 VISUAL EXAMINATION OF BLAST CLEANED SURFACES

After blasting cleaning all items to be visually examined for manufacturing defects which include irregular weld profile, welding spatter, pitting.

#### PSCL-6.7 ELAPSED TIME PRIOR TO LINING

The elapsed time between completion of surface preparation and lining application shall be kept to a minimum. Relative humidity and dew point temperature to be recorded prior to applications.

| % Relative Humidity | Elapsed Time (Hours) |
|---------------------|----------------------|
| 85                  | 0,5                  |
| 80                  | 1,0                  |
| 70                  | 1,5                  |
| 60                  | 1,75                 |
| 50                  | 2,0                  |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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#### **PSCL-6.8 LINING APPLICATION**

The lining application shall be in accordance with the approved procedures of the approved Procedure Qualification Trial. Temperatures to be measured by temperature indicating crayon or infrared / surface temperature gauges. The application of lining shall be as the manufacturers data sheet.

#### **PSCL-6.9 LINING APPLICATION VISUAL**

The coating shall be uniform and free of runs, sagging or lamination.

#### **PSCL-6.10 LINING THICKNESS**

| Lining Thickness required |             |
|---------------------------|-------------|
| Mean (Average)            | 600 microns |
| Minimum                   | 500 microns |
| Maximum                   | 700 microns |

#### **PSCL-6.11 ELECTRICAL INSULATION DEFECT TESTING**

EID / High Voltage Holiday Detection to be performed at 5kV per 100 microns.

#### **PSCL-6.12 ENGINEERS INSPECTION**

Engineers' inspections will be performed as required in reference to agreed PQT and intervention points as agreed on approved Quality Control Plans.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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## PARTICULAR SPECIFICATION: PSPS

### STEEL PIPELINE INSTALLATION

#### PSPS 1 SUPPORTING SPECIFICATIONS

SANS 1200

SANS 62 Steel Pipe and Fittings up to 150mm

SANS 719 Electric Welded Low Carbon Steel Pipes for Aqueous Fluids SANS 044  
Welding

BS 5354 Steel Pipes and Specials for Water and Sewage

API 5L Line Pipe

API 1104 Standards for Welding Pipelines and Related Facilities SANS 1217 Production  
of Painted and Powder coated Steel Pipes

SANS 1117 Plastic Wrappings for the Protection of Steel Pipelines

#### PSPS 2 STORAGE HANDLING AND TRANSPORT OF PIPES, SPECIALS AND FITTINGS

##### PSPS 2.1 General

2.1.1 Where the supply and delivery of pipes, specials, fittings, valves, other materials and equipment are not included in the pipeline construction contract, the Contractor shall be responsible for:

2.1.1.1 The storage care and insurance of pipes, specials, fittings, valves and other materials and equipment supplied under separate contracts as soon as these have been delivered to site.

2.1.1.2 The receipt, provision of craneage and labour for the off-loading of valves, materials and equipment (excluding pipes, specials and fittings) at the store or alongside the pipeline trench.

2.1.1.3 The provision of suitable access along the pipeline route and within the pipeline servitude for the purpose of off-loading pipes, valves, etc and including:

- a. Benching along mild side slopes
- b. Handling and stringing of pipes, specials and fittings at very steep inclines where the pipe supplier will stack the pipes, specials and fittings either at the top or the bottom of these inclines.

The pipe supply contractor will be responsible for the off-loading of pipes, specials and fittings on site.

2.1.1.4 Whenever suitable access to the pipeline servitude is not available, the Contractor shall provide and maintain access as instructed by the Engineer.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



- 2.1.2 The Engineer shall be afforded every opportunity of inspecting such materials on their arrival at Site prior to them being off-loaded. If their condition is unacceptable to the Engineer on arrival, the Contractor shall remove them forthwith from the Site and replace such materials at his own cost and to the satisfaction of the Engineer.
- 2.1.3 Spare pipes shall be stacked where indicated by the Engineer and the damaged reflective coating, shall be repaired.

## PSPS 2.2 Transport

Pipes and specials shall only be transported on properly constructed or adapted vehicles containing correctly shaped and padded cradles or with strong, sawdust filled bags separating pipes and vehicle body as well as individual pipes from each other. Special care shall be taken with the transport of all coated steel pipes as damaged coating might be subject to rejection in terms of Clause 2.1.2

## PSPS 2.3 Handling

- 2.3.1 Pipes, specials and fittings shall not be subjected to rough handling at any time. Under no circumstances shall same be dropped during loading or off-loading or be allowed to collide with each other.
- 2.3.2 Coated steel pipes shall only be lifted by means of broad slings at least 500mm wide support area of pipes up to 500mm NB and 1 000mm wide support area for larger pipes per 12 m length of pipes, or as approved by the Engineer. If more than one pipe is joined, multiple slings shall be used to spread support.

## PSPS 2.4 Storage

- 2.4.1 Pipes shall generally be distributed and stored as closed as possible to the laying position in order to minimise double handling. Where pipes are strung alongside the trench, they should be placed on the side away from excavated material.
- 2.4.2 Where pipes, specials and fittings are to be stockpiled in bulk storage yards, the Contractor shall make his own arrangements for a suitable area which shall meet with the Engineer's approval. The stockpiling area shall be adequately fenced and protected by a lockable gate and a watchman shall be maintained at all times.
- 2.4.3 Pipes and specials shall be strung or stock piled on level, well drained ground in a manner such that they will not be in contact with the ground, tree stumps, or other sharp objects and all vegetation and other combustible material shall be completely removed to at least 5 metres from the nearest pipe or special
- 2.4.4 Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or permanent deformation of coatings. Coated pipes shall not be stacked more than two pipes high, each layer separated by bolsters.
- 2.4.5 The number of layers of bare steel pipes in a stockpile shall not exceed:

$$N = \frac{1\,730 \times Y \times t}{(D-t)^2}$$

Where:

- N = Permissible number of layers  
Y = Minimum yield stress of steel in MPa  
t = Wall thickness in mm  
D = Outside diameter in mm



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 2.4.6 Each class and size of pipe shall be stored separately in its own stockpile.
- 2.4.7 All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weatherproof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived solvents.
- 2.4.8 Valves shall be stored in orderly groups on prepared floors to prevent damage, distortion or corrosion of flanges or working parts. All metal valves may be stored in the open but full protection shall be afforded to valves with non-metallic seals or working parts. Under no circumstances shall valves be stored in direct contact with the ground.

#### **PSPS 2.5 Record of Material on Site**

- 2.5.1 The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site. The record shall at least denote the reference number, size, pressure class, location in the pipeline, date condition of delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.
- 2.5.2 Where pipes, specials and fittings are delivered without reference numbers, same shall be provided by stencilling, labelling or other methods approved by the Engineer.

#### **PSPS 2.6 Repairs**

- 2.6.1 The Contractor shall be responsible for the repair of all defects in pipes, specials, etc, delivered to and accepted on site.
- 2.6.2 the Contractor shall inspect the coating and linings of all factory coated and lined steel pipes and special as follows:
- (i) Epoxy Lining: Shall be inspected in accordance with SANS 1217.
  - (ii) The Contractor to forward repair procedures for the particular coating approved.
- Areas which cannot be tested whilst pipes are supported on cradles or otherwise, shall be tested whilst pipe is suspended above the trench immediately prior to laying. Defective areas of linings and coatings shall be marked when detected and shall be repaired, the Engineer's approval, with material specified respectively for the original and/or coating. Repaired linings and coatings shall be inspected and re-tested after repair and shall have the same properties as specified for the original ones.
- 2.6.3 Repairs to dented steel pipes and special shall only be attempted if the dimensions between the lowest point of a dent and the original pipe contour is less than 2% of the outside diameter of the pipe or special for pipes and specials up to 558,8mm OD and 1% of the outside diameter for larger pipes and specials. Repair of these minor dents shall be done as approved by the Engineer and all such repairs shall be tested by the application of a dye penetrant to detect cracks or laminations in the metal.
- 2.6.4 Dents in steel pipes and specials of which the depth exceed the above limits and any dents which contain scratches or grooves which affect the curvature of the pipe barrels at welds shall be cut out by cutting of a length of pipe barrel long enough to eliminate the defect. Damaged sections shall be replaced in accordance with the Engineer's instructions. The ends of pipes intended for field welding shall be rechambered to 30° + 5° with width of root face 1,6mm + 0,8mm.

Contractor

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## **PSPS 2.7 Maintenance of Cleanliness**

- 2.7.1 End covers to pipes and specials shall be kept firmly in position until installation of same in the trench.
- 2.7.2 The interior surfaces of all pipes, specials, valves and fittings shall at all times be kept free from dust, silt, foreign matter and access for rodents, animals and birds shall be prevented. Pipes and specials shall not be used as shelters by staff or the storage of garments, tools, materials, food containers or similar goods. Care shall be exercised at all times to prevent faecal contamination of pipe interior by staff, casual visitors or passers-by.

## **PSPS 3: LAYING AND JOINTING OF PIPES AND SPECIALS**

### **PSPS 3.1 General**

- 3.1.1 Pipelines shall be laid to straight grades between vertical bends and shall be, within the specified tolerances, to the routes and levels indicated on the approved working drawings.
- 3.1.2 Pipes shall be laid free cold stresses. No deflections shall be taken in curvature of pipes, but shall be taken with approved prefabricated bends with exceptions as hereinafter specified.
- 3.1.3 All deflections under 6° of the axis of pipelines with flexible joints may be made by spreading the deflection over not less than 5 number of joints, provided, provided always that the deflection in any one joint does not exceed those recommended by the manufacturer of the joint after allowance for pipe settlement, heave or other ground or pipe movements.
- 3.1.4 All deflection in the axis of butt welded steel pipelines of under 11.25° or less shall be made by scarfing the end of the two pipes to be joined so that the maximum scarf in any one pipe shall be 5.63°. Where the total deflection is 3° or less, the scarfing may be made in one pipe end only. Ends to be scarfed to be carefully and accurately marked and then either machine cut or machine planed. Hand planing shall not be permitted. After scarfing, the pipe end shall be re-chamfered as described in clause 4.15 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1.5mm and the maximum gap shall be 3.0mm. After scarfing all pipe ends shall be thoroughly cleaned before the field weld is carried out.
- 3.1.5 Except where otherwise provided for, the Contractor shall supply all bolts, nuts, washers, gaskets and other jointing materials for complete installation of pipelines including all specials, fittings, valves, meters, etc.
- 3.1.6 The tolerances allowable for the installation of pipes and specials shall be the same as those laid down for the manufacture thereof.

### **PSPS 3.2 SPECIALS**

- 3.2.1 Fabrications
  - 3.2.1.1 All special shall be fabricated, lined and coated where applicable, in the pipe suppliers works with all flanges and openings protected as specified.
  - 3.2.1.2 Except where otherwise approved by the Engineer in writing, the following field welding will be permitted; tie-ins, the attachment of flanges where the exact position and alignment of same are dependent on site conditions e.g. closure pieces and



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branches for air and access tees. Scour vales tees shall, however, be manufactured in the factory, pre-aligned to the gradients as indicated on the drawings.

### 3.2.2 Installation

#### 3.2.2.1 Bends

Bends shall be installed true to line, level and deflection and shall be anchored in concrete where required to counteract thrust. Bends shall normally be supplied with "centre planes" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends in laying.

#### 3.2.2.2 Tees

Tees for air valves shall be installed with branch barrels vertical. Tees for scour valves shall be installed with branch barrels horizontal or at the gradients as indicated on the drawings. Tees for off-takes shall be installed as shown on the drawings.

#### 3.2.2.3 Flanges

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flange. Flanges shall be installed truly square to the axis of the pipe.

#### 3.2.2.4 Insulated Flanged Joints

Insulated joints shall be provided and installed by the Contractor where specified or instructed by the Engineer. The Contractor shall supply all materials, labour and equipment and shall complete and prove that each insulated joint after installation in the pipeline has a resistance well in excess of the resistance to earth of the pipeline on both sides of the insulating joint.

#### 3.2.2.5 Dismantling Joints

Dismantling joints shall be installed where indicated on the drawing or instructed by the Engineer. These will normally be provided to facilitate the removal of vales or similar fittings from the pipeline. The Contractor shall supply and install dismantling joints with due regard to their pressure rating and mating flanges. The hydraulic pressure restraining tie-bolts shall be carefully installed to tie the pipework across the dismantling joint. Dismantling joint shall be watertight.

#### 3.2.2.6 Thrust Flanges

Where thrust flanges are to be installed on site as for anchoring pipes on steep slopes etc. these flanges shall be supplied by the Contractor split in two equal segments, undrilled with outer perimeter unmachined.

At the point of installation of the thrust flange the pipe coating shall be stripped of the pipe for a distance of 300mm. The flange segments shall be double fillet welded to the pipe barrel around the full circumference and also along both sides of the slit which shall be chamfered for welding. After welding, the coating and lining of the pipe shall be made good.

#### 3.2.2.7 Temporary Closure Pipes

Temporary Closure pieces of the same standard, diameter and wall thickness as the main pipeline shall normally be jointed with flanges and/or flexible couplings, excepts where otherwise specified or instructed by the Engineer.

#### 3.2.2.8 Access Equal-Tees

Access equal-tees shall be required where butt welded pipelines are to be lined in-situ with concrete. These tee shall be spaced throughout the pipeline in accordance



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with requirements of lining operations. Tees shall be of the same standard, diameter and wall thickness as the pipeline.

### **PSPS 3.3 MINOR CONNECTIONS AND OFF-TAKES**

#### **3.3.1 General**

A considerable number of small connections for farms and other minor consumers may be installed during the laying of the pipeline but the position of these will only be fixed on site. Connections of up to 40mm nominal bore shall be permitted to be installed on site without the use of prefabricated branch tees. Typical assemblies of complete minor off-takes are shown on the tender drawings and these consist of branches with an isolating valve fitted in the pipeline, stop cocks, pressure reducing and relief valves, constant discharge orifices, water meters and strainers and manholes around valves and meters, all in accordance with approved drawings. All off-takes shall terminate at pipeline servitude boundaries.

#### **3.3.2 Steel Pipelines**

The contractor shall strip area of pipe coating of 300 x 300 mm. A hole of the required size shall then be cut through the pipe wall in the crown of the pipe and in the centre of the stripped area. A standard boss with female thread of the required size shall be welded over the hole onto the pipe surface using a full fillet weld along the boss perimeter. After removal of welding slag, weld spatter and all foreign matter, the coating and lining shall be made good. The connection shall be off-set from any weld in the pipe barrel. Where the location of the boss in relation to pipe ends or access tees is such that it would be difficult to make good linings, a 200mm nominal bore off-take tee with flange shall be welded onto the pipe barrel. The standard boss shall be provided on a blank flange and the assembly bolted onto the off-take tee.

### **PSPS 3.4 INSTALLATION OF VALVES AND METERS**

3.4.1 The mass of valves or meters shall at no time be carried by the pipe, the flange or the coupling and valve chamber floor shall preferably be cast complete with valve stools and support immediately after installation of valves and meters. Stools shall not be permitted to carry the mass of a valve until at least 7 days after casting the concrete. Alternatively, prefabrication and welding of pipe and valve supports shall comply with the requirements of SANS 10044 Part III and shall be fabricated to the Engineer's approval. Supports shall be welded to pipe only where specified and linings of pipe and specials shall be made good after welding.

3.4.2 Valves and meters requiring special adjustment after installation shall be adjusted and commissioned by the respective suppliers or agents after installation.

3.4.3 Butterfly valves shall be installed with the blade seal retaining ring facing upstream.

### **PSPS 3.5 FIELD WELDING**

3.5.1 All field welding shall only be done by welders who satisfy the requirements of API 1104 and who have been tested at the Contractor's expense by an independent testing authority.

3.5.2 Before any welding of pipeline materials commences, the qualification of welders shall be approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form, and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications.



Contractor



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Witness 2



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Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

- 3.5.3 No welding shall be carried out during rain or high wind or under dusty conditions unless the welder, the weld area and the weld are adequately protected and sheltered.
- 3.5.4 Only welding rods which have been kept dry and uncontaminated shall be used.
- 3.5.5 Welding rods shall be of a grade and quality such that the chemical composition of weld metal and parent metal is similar.
- 3.5.6 Initially 100% of the site welds of each welder shall be examined radiographically in accordance with API 1104. When a 100% success rate of at least ten consecutive welds are achieved by a welder, the frequency of testing may be reduced to 10%.

When a weld defect occurs again, the previous ten welds of the welder must also be radiographically examined and the frequency of further tests shall immediately increase to 100%. Any defect in the previous ten welds will activate the testing of ten further welds until a 100% success rate of the ten welds is achieved. The testing rate may always be reduced to 10% after a 100% success rate of ten consecutive welds.

### **PSPS 3.6 STEEL PIPELINES**

#### **3.6.1 General**

The out of roundness at a plane perpendicular to the pipe axis at any point along the pipeline length shall not exceed 4% of the minimum as laid inside diameter (i.e. +2% of the nominal internal diameter) after completion of the backfilling and with atmospheric pressure inside the pipe.

Out of roundness being measured as the difference between the minimum and maximum inside diameter of the pipe at a point.

#### **3.6.2 Butt Welded Pipelines**

- 3.6.1 Pipes and specials too be joined by field welding shall be supplied with ends bevelled for welding.
- 3.6.2 Field welding of joints shall conform to API 1104.
- 3.6.3 Before welding of joints proceed, pipe ends shall be completely circular and properly mated up by means of backing rings. At least 4 tack welds equally spaced around the pipe perimeter shall be applied to maintain the root gap and position of the pipe for completion of welding. A protective plastic or rubber sheet shall furthermore be placed over the coating adjacent to the joints to protect same from damage caused by welding spatter.
- 3.6.4 Root welds shall thereafter be carried out followed by successive filler passes, and capper passes, all in accordance with the approved welding procedure. Wherever it is possible to have entry into a pipe, inside welds shall be applied first. The inner weld bead shall not extend more than 1 mm into the bore of a pipe or special.
- 3.6.5 Horizontal weld seams or spiral weld seams at pipe ends shall be placed near the horizontal diameter of the pipe or special and shall be staggered so that the circumferential distance between longitudinal or spiral welds intersecting the same circumferential butt weld, is not less than 90 mm nor more than 130 mm apart.
- 3.6.6 Defects caused by stray welding arc flashes, weld spatter etc. shall be removed by grinding provided that pipe wall thicknesses are not reduced to less than the specified minimum thicknesses, otherwise the portion containing the defect shall be cut out and repaired.

Contractor

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Witness 2

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- 3.6.7 During welding of pipes with organic linings, mats of thick rubber felt or other suitable material shall be placed along the pipe invert to protect the pipe lining for the full distance from the point of access up to the point of weld or weld inspection.
- The mats shall be of sufficient width and shall cover a sufficiently wide area of pipe invert to protect the lining against damage due to access by staff, equipment, inspectors or fall out from arc weld. Workmen shall wear soft rubber soled shoes before entering lined pipes.
- 3.6.8 Care shall be taken not to stroke arcs on epoxy lined areas and protective tapes, if any, at ends of epoxy lined pipes shall only be removed immediately prior to welding.
- 3.6.9 Pipes may be welded together alongside the edge of the trench. For factory lined and coated pipes, the maximum length so welded together shall be such that:
- (a) The pipe can be subsequently stored, lifted or handled without damage to linings or coatings.
  - (b) The out of roundness at a plane perpendicular to the pipe axis at any point along pipe length during storage, lifting or handling does not exceed 4% of the minimum inside diameter. Out of roundness being measured as the difference between the minimum and maximum inside diameter of the plane at the point.
  - (c) Safe and easy access to internal tie-in welds are assured for staff and inspectorate with equipment.
  - (d) The maximum length does not exceed 36 metres.
- 3.6.10 Snaking into the trench of butt welded sections of pipe shall be permissible for bare steel pipes, subject to approval by the Engineer of a complete and comprehensive method statement submitted by the Contractor and provided that the out of roundness as defined and measured above during stage of the snaking operation, does not exceed 4% of minimum internal diameter.
- 3.6.11 The linings and coatings of pre-lined and coated pipes jointed together outside the trench shall be made good at these joints outside the trench.

### **PSPS 3.7 PIPELINES WITH FLEXIBLE COUPLINGS**

- 3.7.1 Joints by flexible couplings shall be made only in their final position. Before assembling the joint, care shall be taken to ensure that pipe ends are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present and linings and/or coatings made good where damaged. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.
- 3.7.2 Joints shall be made and couplings assembled to the manufacturer's instructions. Bolts shall be placed with bolt heads alternately pointing in opposite directions.
- 3.7.3 Two-thirds (2/3) of the number of coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly and in a regular sequence by means of a torque wrench.
- 3.7.4 Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the couplings shall carefully be centred over the pipe ends.

### **PSPS 3.8 Flanged Joints**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



- 3.8.1 Flanges shall be truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and at opposite ends tightened equally first.
- 3.8.2 The Contractor shall ensure that the correct jointing materials, i.e gaskets, bolts and nuts are available when required. Only correct diameter and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts. The length of bolts and studs shall be such that at least two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite/grease compound immediately prior to assembly.
- 3.8.3 Flanged fittings shall be so installed that there are no stresses induced into the pipework, specials or fittings by forcing ill fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

### **PSPS 3.9 MAINTENANCE OF CLEANLINESS DURING LAYING**

- 3.9.1 The interior of pipes shall be perfectly clean before being laid the Engineer may instruct pipe interiors to be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately after laying. Once a section of pipeline has been cleared, it shall be sealed off and shall not be entered again unless permitted by the Engineer in writing.
- 3.9.2 The Contractor shall at his own expense make good any damage to valves and fittings or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

### **PSPS 3.10 NIGHT-CAPS**

- 3.10.1 Metal night-caps shall be used to close off all ends of each laid section of pipework is stopped at the end of the day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline. The night-caps shall consist of a steel plate welded into a half coupling which must be provided with a sufficient number of lugs to secure the ring and gasket and shall be strong enough to withstand external water and earth pressure in the event of flooding or collapse of earth and the joint shall be watertight.
- 3.10.2 The Contractor shall also, at his own expense blank-off all air valves and off-takes with 6mm thick blank flanges which shall be bolted with at least four bolts to tee flanges or shall be fixed to plain ended tee branches by half couplings welded to the blank flanges. These shall be watertight and shall not be removed until the valves or other fittings are about to be fitted.
- 3.10.3 Notwithstanding the use of night-caps the Contractor shall at his own expense make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall at his own expense and to the satisfaction of the Engineer clean the interior of the pipeline of such contaminants.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### **PSPS 3.11 PREVENTION OF FLOTATION**

- 3.11.1 Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipework due to stormwater or groundwater entering the trench before backfilling has been completed.
- 3.11.2 Methods adopted to prevent floatation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

### **PSPS 3.12 REPAIRS TO FACTORY APPLIED COATINGS AND LININGS**

- 3.12.1 For the repair of damages to factory applied Coatings caused by transport, handling and storage the contractor shall submit a repair procedure with method statement for the particular pipe coating supplied.
- The repair procedure shall be in accordance with the manufacturers data sheets. All areas of damages to be assessed for size and category of repair.
  - Large areas of damage may require full circumferential tape wrapping with approved tape wrap system.
  - The repair of mechanical damages with the use of the tape patches will not be permitted.
  - All repairs undertaken shall be subject to visual examination and witness of holiday detection by the Engineer / Appointed inspectorate.
  - The Contractor shall keep a record of all repairs on a suitable format approved by the Engineer appointed inspectorate.

### **PSPS 3.13 REPAIRS TO FIELD WELDED JOINTS**

- 3.13.1 Coatings Repairs / Making good of coatings at field joints shall be with a cold applied tape system. The following systems will be considered.

Stopaq Visco Elastic Tape System

Canusa Visco Elastic Tape System

Denso Visco Elastic Tape System Bitumen Tape System Butyl Tape System

The application of approved Tape Wrap System shall be as the manufacturers data sheets. The contractor shall keep application records on an approved format which shall included:

- Field Weld Number
- Chainage
- Batch number of material
- Date of Surface Preparation
- Date of Application
- Visual Inspection
- Thickness Testing
- Holiday Detection



Contractor



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Witness 2



Employer



Witness 1



Witness 2

### 3.13.2 Internal Linings

Repairs / making good epoxy linings shall be with a two part “squish pack” compatible to the factory applied epoxy.

The application of repair materials shall be as per the manufacturers data sheets.

The contractor shall keep application records on an approved format which shall include:

- a) Field Weld Number
- b) Chainage
- c) Batch number of material
- d) Details of Surface preparation which shall include:
  - Preparation / feathering of edges of factory applied Epoxy
  - Grit blasting of field joint
  - Dust and Debris comparisons
  - Surface Profile
  - Date of application
  - Dry Film Thickness Testing
  - EID Testing

All testing to be performed in accordance with SANS 1217.

## PSPS 3.14 HYDROSTATIC TESTING

### 3.14.1 General

Pipelines shall be hydrostatically tested as pipe laying proceeds and after installation of all valves, specials and fittings

The Contractor shall be responsible for providing all water required for testing, the source of which shall be subject to approval by the Engineer.

The Length of pipeline to be tested in one operation shall be as approved by the Engineer.

Where the Method of test is in any way in variance to this specification, the Contractor shall submit a detailed method statement to the Engineer and no test shall proceed before approval of such method statement by the Engineer.

### 3.14.2 Test Pressures

Test pressures shall be as indicated on the drawings. Test pressures shall generally be 1,25 times the pipeline design pressure for design pressures up to and including 3,2 MPa and 1,1 times the design pressure for higher pressure. Design pressure shall be taken as the maximum pressure to which pipelines might be subject under all conditions of operation and shall include allowance for transient pressures.

Test pressure over any length or section of pipeline under test, taking possible differences in elevation along the pipeline into account, shall be such that the test pressure at any point along the section is not less than 1.1 times nor greater than 1,40 times the design pressure at these points.

### 3.14.3 Leakage Rates



Contractor



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Witness 2



Employer



Witness 1



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Leakages of a pipeline under test, taken as the aggregate quantity of water added over a 24 hour period to reinstate required test pressure, shall not exceed quantities equivalent to the following:

Prestressed and reinforced concrete pipeline – 1/3 000 of the volume of water in the section under test.

Steel pipelines with flexible joints – 1/3 500 of the volume of water in the section under test.

Steel pipelines with welded joints – 1/4 000 of the volume of water in the section in the section under test.

The leakage rate at any one joint in the section under test shall not exceed the following:

$Q$  = Allowable leakage in 24 h of pipeline under test in litres/20N

Where:

$Q$  = Leakage rate in litres/hour

$N$  = Number of joints in section under test

#### 3.14.4 State of Valves during Test

The state of valves during the test shall be as follows:

- In-line isolating valves open, except where used to isolate s test length.
- Scour isolating valves closed except as specified
- Off-take isolating valves closed.
- Where two scour valves are provided in series at scour valve chambers the downstream scour valves open.
- Air valve isolating valves open.
- By-pass isolating valves to in-line isolating valves and non-return valves closed.

The Contractors shall be permitted to test against a closed in-line isolating valve. He should bear in mind however that valve gates and seals are not expected to close drop tight at differential pressures exceeding the design pressure of the valve. Design pressures of valves shall be equivalent to a pipeline field test pressure. No relaxation of specified leakage rates shall be permitted due to leaks past gates, blades or seals of isolating valves.

#### 3.14.5 Method of Testing

The Contractor shall provide an approved test pump, an accurate water meter, sealed pressure gauge and autographic pressure recorder, tested and certified by an independent testing organisation, an all other equipment, materials and labour required for the test.

The section of pipeline to be tested shall be clean and closed off as the ends by isolating valves, end caps or approved end-closure pieces. Free ends shall be firmly strutted against solid supports or thrust blocks designed to withstand safely 2 times the calculated end thrust under maximum test pressure. It shall be incumbent on the Contractor to establish the need for blank flanges or isolating valve flanges in order to limit leakage rates pats gates, blades and seals.

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Testing water may be introduced at any air valve within the portion of the pipeline under test. A test manifold shall be placed between the selected air valve and its isolating valve. The manifold shall be provided with three branches, each fitted with drop-tight valves. The main branch shall be sized to suit the Contractor's test pump connection. The two smaller branches shall not be less than 12mm nominal bore fitted with heavy duty needle valves and reducers to suit pressure gauge connections.

A pressure gauge and an autographic pressure gauge respectively shall be connected to each of the smaller branches. A water meter carrying a valid calibration certificate shall be installed between the pump and test manifold. The Contractor shall accurately determine the reduced level at the autographic pressure gauges and enter this level on the recorder chart.

The Contractor shall also enter the reduced level of the highest and lowest invert of the section under test on the recorder chart.

The section of pipeline to be tested shall be slowly filled with clean water quality to the Engineer's approval, great care being exercised to remove all air from the pipeline. The section of pipeline under test shall be completely filled with water and kept full for not less than 7 days in the case of prestressed and concrete pipelines, not less than 3 days in the case of steel pipelines with concrete linings and not less than 1 hour in the case of unlined steel pipelines or steel pipelines with linings other than concrete.

During this initial filling stage, the pipeline joints and all specials, fittings and valves shall be visually inspected for visible leaks and same rectified before proceeding with the test.

After the specified absorption period and with the pipeline full of water, the autographic recorder shall be put into operation at least 15 minutes before pressurisation of the pipeline commences. Water shall be added until the required test pressure is whereupon the valve on the test manifold shall be closed and sealed. The reading on the water meter shall be recorded.

The pressure shall be maintained for one hour and if a pressure drop occurs, more water shall be added to reinstate the test pressure and the valve closed again. The quantity of water added shall be measured by recording the readings before and after pumping.

This procedure shall be repeated for a period of 24 hours, with water added at hourly intervals where necessary to reinstate pressure and water meter readings recorded. At the end of the 24 hours period, the aggregate quantity of water required to reinstate pressure over 24 hours shall be determined.

The Contractor shall give the Engineer 48 hour's written notice of this intention to commence pressure testing and the Engineer may attend and supervise all or any part of tests. All records, recording charts and the attached duly completed hydrostatic test certificate shall be handed to the Engineer as soon as test over any section have been completed.

All valves, specials, fittings and exposed joints, shall be inspected visually during the 24 hours pipeline test and all visible signs of leaks, sweating and distress shall be reported and attended to without delay.

Immediately after completion of the prescribed 24 hours hydrostatic test, all air valves shall be tested in turn before test pressure in the pipeline is released. Each air valve



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Witness 2



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Witness 2

shall be isolated and the drain plug removed. The air valve balls or floats and any actuating linkage shall work freely without restraint. The isolating valve shall be checked for leakage before replacing the plug. Finally, the automatic resealing of the air valves shall be checked by re-opening the isolating valve.

After completing of test on air valves, the section of pipeline under test shall be completely refilled with water, if necessary, any pressurised to static head shown on the drawings. Each scour valve shall be checked by opening isolating valves and sleeve valves where applicable for a duration sufficient to check the complete opening and closing cycles. If necessary, the pipeline shall be refilled after each individual test and re-pressurised to static pipeline head in order to test all scours within the section under test.

#### 3.14.6 Remedial Measures

Should the maximum leakage limits as specified be exceeded, the Contractor shall determine the position and cause of the leaks and shall take remedial measure at his own expense and to the satisfaction of the Engineer to stop such leaks and ensure the specified degree of water tightness.

Under no circumstances shall peening be permitted as a means for stopping leaks, nor shall the pipeline be allowed to remain under extended period of pressure to allow self-sealing with or without sealing aids in the test water. Any leakages from valves not supplied under this contract and which cannot be easily stopped by gland adjustment will be the responsibility of the valve supplier. The Contractor shall in the case of latter event occurring provide and install blank flanges to seal off leaks and to allow testing operations to proceed or to be speeded-up. The supply and installation of these blank flanges shall be covered by a variation to the contract at the rates indicated in the Bill or Schedule of Quantities.

If during the Defect Notification or Liability Period, as applicable, the number of leaks and other defects is considered by the Engineer to be more than could reasonably be expected from a well laid pipeline operating under normal conditions, he may order the Contractor to re-test parts or the whole of the pipeline at the Contractor's own expense and no claims for escalation in costs or for whatever other reasons the Contractor might consider to submit claims shall be considered, except where such re-tests are the result from damages caused to the pipeline by the Employer.

### PSPS 3.15 CONTRACTORS QUALITY MANUAL / QUALITY CONTROL PLANS

The Contractor shall submit a Quality Manual / Quality Control Plan that should at least contain the following for review and approval by the engineer.

- Welding Procedures
- Inspection and Test Plan / Quality Control Plan for pipe installation
- Inspection and Test Plan / Quality Control Plan for external coating at field joints
- Inspection and Test Plan / Quality Control Plan for internal lining at field joints
- Data Sheets for external coating medium at field joints
- Data Sheets for internal lining medium at field joints
- Method statement for the repair of factory applied coatings
- Method statement for the repair of factory applied linings
- Method statement for Hydraulic testing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



- Control Document for Materials receipt
- Control Document for Holiday Detection prior to pipelay
- Control Document for Holiday Detection prior to backfill
- Control Document for Welding of field joints'
- Control Document for NDE requests
- Control Document for filed joint coatings
- Control Document for filed joint linings
- Control Document for chainage records
- Control Document for pressure test record

### PSPS 3.16 INSPECTIONS

3.16.1 Radiographic Examinations shall be performed on the first ten production welds of each elder / operator.

If consistent results are obtained (no welding repairs) the Engineer may consider a reduction in examination frequency.

Should the frequency of Radiographic Examinations be reduced and weld repairs occur the frequency shall be increased.

All field welds will be visually examined externally / internally.

Fillet welding on site will be examined by Liquid Penetrant or Magnetic Particle test methods.

All coatings and linings of field joints will be examined by the Engineer or appointed inspectorate for compliance to the Inspection and Test Plan / QCP's.

The Contractors data books will be reviewed on a weekly basis

## PARTICULAR SPECIFICATION

### PSVA: DESIGN, MANUFACTURE AND INSTALLATION OF VALVES

#### PSVA 1 SCOPE

This specification deals with the supply and delivery of the following types of valves for controlling the flow and pressure of treated and untreated water at temperatures not exceeding 50° C in small and large diameter medium pressure pipelines:

- a) Wedge type Gate Valves
- b) Butterfly Valves
- c) Automatic Control valves
- d) Non-Return Valves
- e) Air Valves

#### PSVA 2 APPLICABLE SPECIFICATIONS, STANDARDS AND DEFINITIONS



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



## PSVA 2.1 SUPPORTING SPECIFICATIONS

Where this specification is required for a project, the following codes, specifications and standards shall, inter alia, form part of the contract document:

- a) DWS 2510
- b) SANS 1123
- c) SANS 664
- d) BS 5155
- e) ISO
- f) DIN
- g) ANSI

When reference is made to a code, specification or standard, the reference shall be taken to mean the latest edition of the code, including addenda, supplements and revisions thereto.

## PSVA 2.2 DEFINITIONS

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in PSVA 2.1 above:

- a) Face to face dimensions: The distance between the two planes perpendicular to the body axis located at the extremities of the body and ports.
- b) Nominal pressure (PN): All pressure units throughout the valve specification will be recorded in kPa taking into account the following:
  - The maximum allowable working pressure depends upon the materials, design and working temperature and shall be selected from the pressure/temperature rating tables in the appropriate standards.
  - It is designated by PN followed by the allowable working pressure.
  - This definition is in accordance with ISO 7268.
- c) Nominal size (DN): A numerical designation of size that is common to all components in a piping system other than components designated by outside diameters. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions in mm.

## PSVA 3 DEVIATIONS

The Employer shall not permit any substitution or deviation from the requirements of this Specification without prior approval. Any substitution or deviation from the original Specification shall be submitted to the Engineer for approval. Deviation shall only be considered during the tender stage of the project.

## PSVA 4 QUALITY CONTROL

### PSVA 4.1 QUALITY MANAGEMENT SYSTEM

The valve manufacturer and all manufacturing subcontractors shall have a Quality Management System in accordance with ISO 9001, which shall be certified by a recognised certification authority or body. Proof of ISO 9001 certification for the valve manufacturer and all subcontractors shall be provided at time of tender.

### PSVA 4.2 RESPONSIBILITY FOR QUALITY



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The manufacturer shall implement a comprehensive Quality Control programme and accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Engineer or his appointed representative.

In keeping with the principles contained in the abovementioned code of practice, the manufacturer or any nominated or approved subcontractor(s) shall :

- a) Be responsible for compliance with all the clauses of this specification in every respect;
- b) Carry out all inspections and tests called for in the specification in the presence of the Engineer or his appointed representative. The cost of these inspections and tests shall be included in the tender price; and
- c) Draft a quality control plan for manufacture indicating all the intended stages of testing during manufacture, cleaning, preparation and application of the corrosion protection system specified, as well as hold points for independent quality surveillance.

#### **PSVA 4.3 NOTICE OF INSPECTION**

The Engineer shall be notified at least seven days in advance, or as otherwise agreed, of impending inspections or when cleaning and first coating are to be carried out as well as for witnessing the points in terms of the agreed Quality Control Plans.

#### **PSVA 4.4 SUBMISSION FOR APPROVAL**

The following shall be submitted to the Engineer, including data sheets where applicable, for approval before work is started:

##### ***PSVA 4.4.1 Manufacture***

- a) Drawings, including general arrangement and detailed drawings;
- b) Programme;
- c) Quality control plan;
- d) Draft Operational and Maintenance Manual.

##### ***PSVA 4.4.2 Corrosion protection***

- a) Programme;
- b) Quality control plan;
- c) Details of blast materials;
- d) Details of coating products;
- e) Details of pickling and passivating products.

##### ***PSVA 4.4.3 Manufacture and corrosion protection programme***

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted :

- a) Inspection of material;
- b) Hydrostatic testing of uncoated castings, pipes and fittings;
- c) Manufacture of components;
- d) Fettling or dressing;
- e) Degreasing;
- f) Water soluble salts test;
- g) Blast cleaning and application of first coat;
- h) Application of intermediate and final coats;



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- i) Commencement of site repairs.

#### **PSVA 4.5 SUBSTANDARD QUALITY CONTROL**

All material, certification and records of the manufacturer shall be subject to examination by the Engineer.

This shall include the checking and testing of equipment. If any deviation is found, additional testing and quality surveillance shall be carried out.

If the additional testing confirms inaccurate quality control by the manufacturer, all work shall be stopped and shall only proceed after remedial action has been implemented.

#### **PSVA 4.6 ACCESS FOR SURVEILLANCE**

For the purpose of carrying out surveillance, the Engineer or his representative shall be granted access to any part of the manufacturer's premises relevant to the work being carried out, at any reasonable time.

#### **PSVA 4.7 COST OF QUALITY CONTROL**

The cost of quality control shall be included in the tender price. When surveillance results in rejection of the lot or when notice by the manufacturer results in a fruitless trip, the cost shall be recovered from the Contractor appointed under the Contract.

If additional inspections, tests and analyses requested by the Engineer prove that the manufacture and/or corrosion protection is in accordance with the specifications, the costs of the inspections and/or tests including transport and accommodation, if applicable, shall be paid by the Employer. Should however the additional investigations prove that the manufacture and/or corrosion protection is not in accordance with the specifications, the cost shall be recovered from the Contractor.

The Employer shall have the right, without prejudice to any other legal remedy, to deduct such costs from payments due to the Contractor under the Contract.

#### **PSVA 4.8 NON-COMPLIANCE WITH THE SPECIFICATIONS**

Valves, associated equipment, materials and corrosion protection that do not confirm to the requirements of this Specification shall be rejected.

Such rejected valves, associated equipment, materials and/or corrosion protection shall be held at the cost of the Contractor who shall, when called upon, and at his own cost, repair the defects or corrosion protection according to the Contract.

Failing satisfactory repair of rejected valves, associated equipment, materials and/or corrosion protection, the valves, associated equipment and materials shall be returned to the Contractor, as applicable, at his cost and risk without any opportunity to substitute the rejected equipment. Alternative valves, associated equipment or materials may be purchased by the Employer at the Contractor's expense or an approved contractor may be appointed to repair the valves, associated equipment, materials and/or corrosion protection.

#### **PSVA 4.9 FINAL ACCEPTANCE**

No valves, associated equipment or materials shall be accepted nor be delivered to site unless all Quality Control requirements have been complied with.

#### **PSVA 4.10 QUALITY CONTROL RECORDS**

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#### **PSVA 4.10.1 Coating and material records**

Quality control, material and coating records for all stages of the work, i.e. batch numbers of materials used, environmental conditions and all test data shall be recorded on the approved Quality Control Plan for manufacturing and corrosion protection.

Certificates for all materials used shall also be required.

#### **PSVA 4.10.2 Data sheets, specifications and codes of practice**

The Manufacturer shall have available the latest issues of the following :

- a) A copy of this Specification;
- b) Relevant Standard Specifications and Codes of Practice;
- c) Data sheets for materials used.

#### **PSVA 4.10.3 Quality control records**

Accurate and detailed quality control records shall be kept by the Contractor for all stages of the manufacture and supply of the valves and associated equipment and materials.

All quality control records shall be available for inspection by the Engineer or his representative.

Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the specifications.

The collection of documents for each valve or item or equipment shall be collated and bound in a logical manner and retained by the Contractor as proof of quality achieved. These shall be available on demand for quality control and payment releases. No payment for any valve shall be made unless the quality control records have been made available to the Engineer. The records shall be handed over to the Engineer on completion of the Contract or bound into the Operation and Maintenance manuals where such manuals are supplied.

### **PSVA 4.11 QUALITY SURVEILLANCE BY THE ENGINEER**

#### **PSVA 4.11.1 Inspection by the Engineer**

Inspection of valves and equipment shall be carried out by the Engineer, his representative or a nominated and approved inspection authority at the manufacturer's and corrosion protection applicator's works.

Inspection by the Engineer, his representative or a nominated and approved inspection authority shall in no way relieve the manufacturer or Contractor of any of their obligations to design, manufacture and supply valves and equipment of the quality and workmanship required in terms of the Contract.

#### **PSVA 4.11.2 Independent surveillance**

The Engineer may employ an independent, technically qualified person or organisation to carry out quality surveillance of the work on his behalf.

The inspection authority has the right to inspect any item covered in the Contract at any stage of execution of the Contract.

Where imported valves or supplies are to be inspected before shipment, the Contractor shall notify his suppliers abroad of the conditions applicable to inspections and also request them to notify the Engineer when consignments are ready so that arrangements can be made for the required inspections.

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Contractor

Witness 1

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### **PSVA 4.11.3 Material tests**

The manufacturer's material test data certification and quality records shall be subject to examination by the Engineer or his representative. Reasonable samples of the cleaning and coating materials shall be provided for testing at the Engineer's discretion.

Rejection of the materials shall place a hold on the use of the materials of the same batch number and any components that have already been cleaned / coated with rejected material shall be reworked at no additional cost to the Employer.

### **PSVA 4.11.4 Destructive testing**

The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the corrosion protection specifications. Areas thus damaged shall be repaired by the Manufacturer / Contractor to the satisfaction of the Engineer at no additional cost.

## **PSVA 5 GENERAL CONDITIONS AND REQUIREMENTS**

### **PSVA 5.1 NOMINAL PRESSURE**

Each valve is assigned a nominal pressure (PN) in kPa and shall be tested in accordance with these specified pressures.

### **PSVA 5.2 MINIMUM PRESSURE RATING**

1 000 kPa is considered to be the lowest acceptable pressure rating for any valve irrespective of lower system pressures.

### **PSVA 5.3 DESIGN LIFE**

All valves and appurtenant fittings shall be designed for a useful life of forty-five (45) years under the operating conditions specified in the Project Specification.

### **PSVA 5.4 GUARANTEE**

All valves shall be guaranteed against faulty design, materials and workmanship for a minimum period of ten (10) years from date the Completion Certificate, unless otherwise specified. During this period the Contractor shall attend to and rectify at his own cost any defects that can be attributed to faulty design, materials and workmanship. Normal wear and tear shall be excluded.

### **PSVA 5.5 FLANGES**

Unless specified under the Project Specification, all valves shall be double flanged and drilled off centre to SANS 1123. Flange thickness shall be in accordance with BS 4504 for cast iron valves and SANS 1123 for fabricated valves.

Should a required flange size fall beyond the range of SANS 1123, mating dimensions shall be in accordance with BS 4504.

Flanges with a pressure rating between 1000 - 1600 kPa shall have flat joint faces machined in accordance with the above SANS or BS specifications. Flange pressure ratings that exceed 1600 kPa shall incorporate an "O" ring sealing arrangement. Details of the proposed "O" ring groove shall be furnished at the tendering stage for consideration.

Flange sizes exceeding and including DN 1500 shall however incorporate an "O" ring sealing arrangement irrespective of pressure rating.



Contractor



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Witness 2



Employer



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The periphery of all flanges shall be machined to the correct outside diameter dictated by the flange pressure rating. Flanges for pipes and fabricated valves shall be machined on both faces. All holes, shall be drilled perpendicular to the face and spot machined on the bolt head / nut bearing faces.

Sufficient clearance shall be allowed between the body and flange to enable flange bolts to be removed or tightened. Tapped holes shall only be permissible where stiffening ribs or shaft bosses interfere with bolts.

One flange of the valve body shall be clearly marked, identifying the respective pressure rating (Refer to Paragraph 5.12).

#### **PSVA 5.6 JOINTING MATERIAL AND FASTENERS**

Valves shall be supplied complete with bolt units, consisting of a standard length bolt, nut and two washers. The stud unit, where applicable, shall be supplied with a standard length stud, nut and washer. A washer shall be fitted under all bolt / screw heads and nuts.

The shortest standard bolt or stud that protrudes beyond the nut by a minimum of two threads when the assemblies are fully tightened shall be used. The same applies to stud units. The amount by which the bolt or stud protrudes beyond the nut shall therefore not exceed 10mm plus 2 threads. Care shall be taken to ensure that the correct bolt length is used taking into account the actual flange thicknesses on the particular installation.

Where hot dip galvanised bolts are used, the bolts may not be cut, after galvanising, to comply with the abovementioned length specification.

The manufacturer shall specify a fastening sequence for bolts (if applicable) and the torque settings (in Nm) for all bolts. These torque settings and fastening sequences shall be included in the Operation and Maintenance Manual.

In addition each valve shall be supplied with full-face gaskets or "O" rings for joining up to adjacent flanges.

Depending on the valve location in a piping system and the atmospheric conditions, the following specifications will apply:

- a) Black bolted units to SANS 135;
- b) Precision bolted units to SANS 136;
- c) Galvanised bolted units to SANS 763;
- d) Stainless steel bolted units to DIN 931;
- e) Stainless steel set screws to DIN 933.

For all valve components, i.e. bonnet covers, glands etc., drilled holes for bolts shall be perpendicular to the flange face.

All bolts and stud units shall be the same length and appropriate size. When required by the Project Specification, isolating bolt units shall be supplied with bolt, nut, two washers, an isolating sleeve and two isolating washers.

#### **PSVA 5.7 CONTACT BETWEEN DISSIMILAR METALS**

The Contractor shall ensure that metals and alloys are compatible or are adequately protected if, in the galvanic series, there is more than 0,3 Volt difference in the galvanic potential.

#### **PSVA 5.8 VALVE SUPPORTS AND LIFTING**

Valves of DN 400 and larger shall have supporting feet cast integrally with the valve body.



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Each valve over DN 300 or 100 kg mass, shall have two eye bolts of the required strength securely attached to the valve body to facilitate easy handling during transport and installation.

## **PSVA 5.9 BYPASSES**

Where specified in the Project Specification, valves shall be fitted with bypasses and bypass valves. Piping shall be flanged.

Bypasses shall be bolted to the valve body and not to the adjoining pipe work. Piping and fittings shall be hot dipped galvanised after fabrication.

## **PSVA 5.10 WELDING**

Welding shall be in accordance with BSS 2633 and BSS 5135 for mild steel and BSS 4677 for corrosion resistant steel.

Welding of flanges shall be in accordance with BSS 806 Type 6.

Weld strength shall be at least 90 % of that of the plate calculated on the original measured thickness of the plate before welding.

The welding process used should limit heat input to a minimum and can include manual metal arc (MMA) and metal inert gas (MIG).

## **PSVA 5.11 PRESSURE GAUGES**

Where specified in the Project Specification, valves shall be fitted with glycerine filled pressure gauges complete with separate stainless steel isolating ball cocks. The pressure gauges shall in general conform to SANS 1063.

The gauge face shall have a minimum diameter of 100mm with black lettering and needle on a white background. A red line or needle shall indicate the maximum safe working pressure, where applicable. Pressure gauges shall be calibrated in increments of 5 % of the full scale reading. The normal working pressure shall give a reading of between 50 and 75 % of the full scale.

## **PSVA 5.12 MARKING**

### **PSVA 5.12.1 General**

Each valve shall be clearly marked in accordance with the requirements of BS 5418.

### **PSVA 5.12.2 Body marking**

All valve bodies shall be permanently and indelibly marked (cast in 15mm minimum lettering size on castings or welded on fabricated valves) as follows:

- a) Nominal size (DN in mm);
- b) Nominal pressure (PN in kPa);
- c) Arrow to indicate the direction of flow;
- d) The contract number plus identification number to identify each individual valve;
- e) Material of construction.

The above markings shall be legible after painting.

In order to facilitate identification at the factory and at site, all valve bonnets, gates, discs, doors, etc. shall be permanently marked (cast in or welded on in 15mm minimum lettering) with the contract number and an identification number for each individual valve.

In addition to the above, one flange for a flanged valve shall be clearly marked with a single set of machined notches (at least 3mm wide, 3mm deep and the length of the notch to suit the width



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of the flange). For wafer type valves, the width and depth of the notch shall be identical to that of the flanged valves. The length of the notch however shall be 8mm long for the following operating pressures:

- a) One notch - 1000 kPa
- b) Two notches - 1600 kPa
- c) Three notches - 2500 kPa
- d) Four notches - 4000 kPa

#### **PSVA 5.12.3 Identification plate markings**

Identification plate markings shall be hard-stamped, printed or engraved on a stainless steel nameplate fitted to the valve with stainless steel screws. If necessary a boss / raised face shall be cast as part of the body to fit the nameplates.

- a) Information listed on a name plate shall be as follows:
- b) Manufacturer's name or trade mark;
- c) Nominal size (DN);
- d) Contract number;
- e) Nominal pressure (PN) in kPa;
- f) Serial number;
- g) Item number;
- h) Material, disc/gate and body;
- i) Date of manufacture;
- j) Mass of valve in kg;
- k) BS/SANS specification.

#### **PSVA 5.12.4 Position indicators**

Position indicating plates shall be embossed to clearly show the fully open and closed positions as well as the  $\frac{1}{4}$ ,  $\frac{1}{2}$ , and  $\frac{3}{4}$  intermediate positions.

Electronic position indicators are preferred. Full details must however be supplied with the offer. Special valve position indicators, calibrated in the specified increments of the valve opening, shall be designed, supplied and installed as required in the Project Specification.

The indicator system shall be accurately installed and calibrated to give true linear indication of the valve opening. Calibration of the indicator scale shall be done in-situ and directly recorded against the actual valve operation.

All pulleys, brackets, pins, cables, counterweights, sleeves, indicator gears and fasteners shall be of stainless steel 304 or better.

#### **PSVA 5.13 PRESSURE TEST REQUIREMENTS**

Valves shall be pressure tested by the manufacturer to prove that all the fully assembled valves are capable of functioning satisfactorily under the specified operating conditions.

All materials and workmanship shall be the best of their respective kinds and shall be subjected to the tests prescribed in the latest amendments of the relevant SANS or BS Specifications.

All final product testing shall be carried out to the methods and tolerances specified in the relevant SANS or BS Specifications.

The supplier shall bear the cost of carrying out the tests prescribed by the codes.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### **PSVA 5.13.1 Pressure testing**

Test flanges shall be used, tapped holes in valve bodies are unacceptable. Tie-bolts or other forms of restraint applied across the blank flanges for the testing of flanged valves shall not be permitted.

Note :

- a) No valve undergoing pressure testing shall be subject to shock loading.
- b) Valves and connections shall be purged of air prior to pressure testing.

### **PSVA 5.13.2 Test fluid**

The test fluid for all pressure tests shall be either water with the addition of a suitable inhibitor, or another liquid whose viscosity at ambient temperature is equal to or less than that of water.

### **PSVA 5.13.3 Test procedures**

#### **General**

Test pressures shall be maintained for not less than a two minute duration or as otherwise specified by the Engineer and the valves shall be watertight in all respects.

Structural and seat test shall be executed on both sides of double seated valves i.e. gate valves.

All valves, completely assembled, shall be pressure tested by the manufacturer in accordance with Table 1.

**TABLE 1 : APPLICABILITY OF PRESSURE TESTS**

| TEST               | SERVICE APPLICATION |             |            |
|--------------------|---------------------|-------------|------------|
|                    | TIGHT SHUT-OFF      | LOW LEAKAGE | REGULATING |
| Structural         |                     |             |            |
| (i) Body           | √                   | √           | √          |
| (ii) Disc strength | √                   | √           | N/A        |
| Seat/Seal          | √                   | √           | N/A        |

#### **Structural test**

All structural tests shall be done at 1.5 x maximum permissible working pressure at ambient temperature.

Seepage past gland seals during structural tests shall not be cause for rejection, provided that the gland seals are watertight when the internal pressure is reduced to the maximum permissible working pressure at ambient temperature.

#### **Body**

Testing shall be carried out before valves are coated or lined with materials that are capable of sealing against leakage. Both ends of the body shall be blanked off so that the valve is subjected to the full pressure stresses in all directions induced by the test pressure.

The valve disc shall be in the open or partially open position during the test. There shall be no visually detectable leakage through the shell of the valve during the test period.

#### **Disc / Gate strength**

The valve shall be closed in the normal manner, and the test pressure applied to one side of the disc with the other side open to atmosphere. There shall be no visible evidence of structural damage to or deformation of the disc or of leakage through the disc during the test duration.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### Seat / Seal test

Each assembled valve shall be subjected to open-end tests for leakage up to 1.1 x the permissible working pressures at ambient temperature. Valves shall be drop tight over the complete range of pressures. Valves with symmetrical seatings shall be tested in either direction.

The maximum permissible leakage shall be as given in Table 2.

**TABLE 2 : TEST PRESSURE LEAKAGE RATES**

| VALVE TYPE     | LEAKAGE RATE                                        |
|----------------|-----------------------------------------------------|
| Tight shut-off | Rate 3 * : No visible leakage for duration of test. |
| Low leakage    | Rate 1 : 0.1 mm <sup>3</sup> /s x DN                |

\* Leakage rates are defined in BS 5146 : Part 2.

### **PSVA 5.13.4 Hydraulic testing**

Before dispatch to site, valves shall be tested at the manufacturers' works in accordance with the requirements of Table 3 below, as applicable.

The Engineer may request that certain testing procedures be witnessed. In such case, the Contractor shall ensure that at least 48 hours written notice be given to the Engineer to enable the tests to be witnessed.

**TABLE 3: HYDRAULIC TEST REQUIREMENTS**

| Class & Working Pressure (MPa)       | Test Pressure on Body (MPa) | Test Pressure Gate/Disk (MPa) | Droptight Pressure (MPa) | Applicable Standard |
|--------------------------------------|-----------------------------|-------------------------------|--------------------------|---------------------|
| Wedge Gate and Resilient Seal Valves |                             |                               |                          |                     |
| Class 10                             | 2,0                         | 1 ,5 up to 450Ø               | 1,0                      | SANS 664            |
| Class 16                             | 3,2                         | 2,4 up to 450Ø                | 1,6                      |                     |
| Class 25                             | 5,0                         | 3,7 up to 450Ø                | 2,5                      |                     |
| Class 40                             |                             |                               |                          |                     |
| Butterfly Valves                     |                             |                               |                          |                     |
| Class 10                             | 1,5                         | 1,5                           | 1,1                      | BS 5155             |
| Class 16                             | 2,4                         | 2,4                           | 1,75                     |                     |
| Class 25                             | 3,7                         | 3,7                           | 2,75                     |                     |
| Class 40                             |                             |                               |                          |                     |
| Non-Return (Check) Valves            |                             |                               |                          |                     |
| Class 10                             | 1,5                         | 1,0                           | N/A                      | SANS 1551           |
| Class 16                             | 2,4                         | 1,6                           | N/A                      |                     |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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|----------|-----|-----|-----|--|
| Class 25 | 3,7 | 2,5 | N/A |  |
| Class 40 |     |     | N/A |  |

#### **PSVA 5.13.5 Test certificates**

All valves must be supplied with hydraulic test certificates. In the case of valves smaller than 350mm diameter, a certificate for the batch, if more than one valve is ordered, will be acceptable.

The test certificates for individual valves shall have a specific code / number which relates to the same code / number on the valve;

- (a) contain a statement by the manufacturer that the valve(s) have been tested in accordance with this standard; and
- (b) state the actual pressures and medium used in the test.

#### **PSVA 5.13.6 Anti-static**

Valves designated as anti-static shall have electrical continuity between shaft, disc and body when tested in accordance with A.2 of BS 5146 : Part 1.

#### **PSVA 5.14 FUNCTIONAL TEST REQUIREMENT**

The manufacturer shall do a functional test on each valve. This shall consist of taking the valve through one complete cycle, from fully closed to fully open and back. The manufacturer shall take particular note that the valve position indicator is correctly calibrated.

#### **PSVA 5.15 EQUIPMENT DRAWINGS**

The Contractor shall submit drawings for the following purposes :

- Tendering;
- Manufacture for approval;
- Installation for approval;
- As-build records.

No valve shall be supplied prior to the Engineer approving the manufacturing drawings. Any valve supplied before the drawings are approved, shall be at the Contractor's risk.

#### **PSVA 5.16 OPERATING AND MAINTENANCE MANUALS**

Five copies of Operating and Maintenance Manuals shall be supplied. A Draft copy of the manual shall be submitted for approval before the final copies are submitted.

##### **PSVA 5.16.1 Contents**

The purpose of these documents is to simultaneously provide a permanent and accurate record of all the equipment provided as well as a usable guide in simple language covering operating, maintenance and fault finding procedures.

##### **PSVA 5.16.2 Binding**

The manuals shall be securely bound in A4 size, hard backed plastic / waterproof 4- ring binders, with clear pockets on the spine and front cover for the insertion of title slips, giving the Contract Number, Scheme, Dam and a description of the equipment supplied.

Drawings larger than A3 size, index and other title pages shall be contained in separate plastic pockets, bound in the appropriate section.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### **PSVA 5.16.3 Layout**

The sections shall be separated by plastic dividers, clearly and visibly marked to match the index, and shall be set out as follows:

- (a) Title page
- (b) Index
- (c) Specification and Technical Schedules
- (d) General description with test certificates and final test certificate relating to any tests carried out;
- (e) Operating Instructions: These shall be clear, concise and easy to follow and must include, where applicable, pre-start, safety and shut-down procedures;
- (f) Routine maintenance and lubricating schedule;
- (g) Fault diagnosis and repair procedure;
- (h) Detailed schedule of plant components giving materials, corrosion protection, part numbers, etc.;
- (i) Spare parts list: Suppliers / Agents details must be provided;
- (j) Drawings. They shall include: general arrangements, assembly drawings, hydraulic and electrical diagrams, parts and material list in A3 and flow discharge curves. Suppliers / Agents ORIGINAL brochures and instrumental literature shall also be incorporated in the manual.

### **PSVA 5.17 HANDLING AND TRANSPORT**

The Contractor is responsible for the safe and undamaged delivery of equipment.

After final product inspection and approval, the valve and related fittings shall be securely packed to prevent damage in transit.

In order to protect the corrosion protection (lining), the ends of valves and fittings shall be securely blanked off with sturdy blank flanges which shall be clearly marked:

**"DO NOT REMOVE UNTIL FINAL INSTALLATION"**

Plastic sheeting will not be acceptable.

Bolts and other small parts shall be sewn up in strong bags and crated. The bags shall be tagged using metallic tags and indicate the following information:

- (a) Manufacturer's identification and contract number;
- (b) Part numbers;
- (c) Description;
- (d) Sizes; and
- (e) Quantities.

Each bag shall have the delivery address listed on a separate metallic tag.

The use of ropes, wire or chains for lifting without suitable padding is strictly forbidden. For transport or storage purposes, bunks of timber shall be used to support the components on any surface and separate them from each other.

Precaution shall be taken to support and chock the equipment to prevent movement when loading onto vehicles. Components shall be firmly lashed or chained with padded lashing supported on sawdust bags. The area of padded surfaces shall be adequate to prevent damage to coatings.

The Site Engineer shall be notified of the delivery date and of any requirements regarding off loading and storage at site.

Contractor

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Witness 2

Employer

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For site delivery, the transportation and supervision during off-loading will be the responsibility of the Contractor. The final inspection and acceptance of equipment supplied will be undertaken on site after off-loading has been completed. Any damage that occurs during the handling, assembly and storage of equipment at the Manufacturer / Contractor's works, including transportation to site, shall be repaired by the Contractor at his own cost, in accordance with the valve specification and to the satisfaction of the Engineer.

## **PSVA 6 WEDGE GATE VALVES**

### **PSVA 6.1 GENERAL**

Gate valves shall be of the resilient seal or wedge-gate type, the gates of which shall be completely clear of the waterway in the fully open position. Unless otherwise specified, the gate valves shall be of the non-rising spindle type. The valves shall be capable of withstanding the nominal pressure (PN) and specified test pressures from both sides. The gate shall operate satisfactorily under the specified conditions.

In specific circumstances the valves have to be drilled to suit existing equipment and details thereof will be supplied in the Project Specification.

Gate valves shall be of the nominal bore, class, type and working pressure as detailed in the Bill of Quantities and shall comply with the following detailed requirements:

### **PSVA 6.2 MANNER OF OPERATION**

#### **PSVA 6.2.1 Valve rotation**

Unless otherwise specified in the Project Specification, the valve shall be closed by turning the spindle anti-clockwise when viewed from above the spindle.

In the case of valves fitted with a reduction gearbox, the geared spindle shall rotate as specified above. The valve gearbox, where applicable, shall not be mounted directly onto the stuffing box but shall be mounted on suitable supporting brackets.

The direction of opening of the valve shall be clearly indicated on the bonnet of the valve.

#### **PSVA 6.2.2 Sealing ability**

Valves are to seal drop tight at the pressures specified in Table 2: Hydraulic Test Requirements.

#### **PSVA 6.2.3 Spindle**

Valves shall be of the non-rising spindle type.

#### **PSVA 6.2.4 Opening and closing torque**

All valves shall be designed to be opened or closed against an unbalanced head equal to the maximum rated working pressure of the valve or a lower pressure if so stated in the Project Specification. The torque required to open or close a valve as stated above shall not exceed the following:

- 100 Nm in the case of valves up to 300 mm ND.
- 300 Nm in the case of valves over 300 mm ND.

#### **PSVA 6.2.5 Spindle cap**

Valves shall, unless otherwise specified herein, the Drawings or the Bill of Quantities, be fitted with a spindle cap which is locked to the valve spindle by means of a 12mm set screw.

## **PSVA 6.3 THRUST BEARINGS**



Contractor



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Gate valves with a nominal bore of 225mm or larger shall be fitted with ball-bearing type thrust faces above and below the spindle thrust collar. The thrust faces shall be housed in a sealed grease packed enclosure. It will be considered an advantage if these thrust faces can be re-greased with the valve under pressure.

All gate valves shall be fitted with a back seal to permit the replacement of the stem seals under pressure.

#### **PSVA 6.4 GLAND PACKING**

Spindle seals may be of the stuffing box and gland or O-ring type.

#### **PSVA 6.5 SEAT RINGS**

Valves of nominal bore up to and including 300mm shall have seating rings pressed into undercut recesses, machined into both gate and body in such a manner that the permanent distortion of the seating ring prevents them from becoming loose.

#### **PSVA 6.6 CONSTRUCTION MATERIALS**

All materials used in the construction of gate valves shall comply with the requirements of SANS 191 and SANS 664 as relevant.

For gate valves for working pressure up to 1,6MPa and over DN 50 but not exceeding 600mm the valve body shall be of cast iron and shall comply with the relevant requirements of SANS 664.

For gate valves for working pressure over 1,0MPa and of diameter exceeding DN 600 the valve body shall be of cast steel and shall comply with the relevant requirements of SANS 191.

Valve trim shall be either manufactured from Copper alloy or Stainless steel as per Appendix D of SANS 664.

All copper/zinc alloys used shall be dezincification resistant. Galvanised fittings shall not be used on any part of a valve. The supplier shall provide full details of materials used for the valve construction.

#### **PSVA 6.7 END CONNECTIONS**

Gate valves shall be provided with double flanged or double spigotted or double socketed end connections, as detailed.

##### ***PSVA 6.7.1 Flanged valves***

Unless otherwise specified in the Project Specification, valve flanges shall be drilled off centre to the specified pressure table and in accordance with the requirements of the latest revision of SANS 1123. Tapped holes are unacceptable except where stiffening ribs interfere with bolting. The front faces of all flanges shall be fully machined.

Flanged valves shall be supplied complete with all jointing material such as gasketing, bolts, nuts and washers necessary for both flanges. Bolts are to be of such length that, when the valve is bolted to a steel flange with thickness as per 854504, between zero and two threads protrude past the nut.

##### ***PSVA 6.7.2 Spigotted and socketed valves***

The ends of Spigotted and Socketed valves shall be machined to be compatible with CID or COD fibre cement pipes, uPVC or GRP pressure piping as specified in the Scope of Work or in the Bill of Quantities. End connection dimensions shall be compatible with SANS 1223, SABS 966 and SANS 997.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



## **PSVA 6.8 WEDGE-GATE VALVES**

### **PSVA 6.8.1 Gate and guides**

Channel guides on the body and the shoes on the gate shall be as deep and as long as necessary to support and minimise shudder of the gate in any position during its travel.

Shoes shall be accurately fitted in the guides so as to ensure that sealing rings do not make contact before the gate is seated and that the gate is centralised when seated.

The sliding surfaces between the shoe and the channel shall be constructed from acceptable dissimilar materials.

With the valve fully open, at least half of the shoe shall be supported by the guides.

Jacking screws shall be provided to prevent over travel of the gate when closed. The design of the gate and guides shall be such that both pressure and/or flow may be applied from either side of the gate.

Gate valves of nominal bore not exceeding 300mm shall be capable of being installed in any position.

### **PSVA 6.8.2 Stems**

The stem thrust collar shall bear against a ball thrust bearing of approved design, details of which shall be furnished at tendering stage.

### **PSVA 6.8.3 Sealing faces**

Body and gate seals shall be of such design and construction that will prevent seals becoming loose and prevent water passing behind seals under all conditions of operation and test. This feature must be proven at tendering stage by suitable drawings and documentation.

The leading edges of the sealing rings shall be slightly chamfered.

### **PSVA 6.8.4 Position indicators**

All valves of DN 300 and larger shall, except where otherwise specified, be fitted with mechanical indicators to show the position of the gate.

### **PSVA 6.8.5 Gate and body marks**

One face of the gate shall be marked, corresponding to a similar mark on the body, to ensure correct replacement after dismantling. The marks shall be visible and clear after coating.

## **PSVA 6.9 RESILIENT SEAL GATE VALVES**

### **PSVA 6.9.1 Body and guides**

The valve body shall incorporate a straight unobstructed body passage without pockets and shall have inclined seats and prominent gate guides to eliminate deposits in the valve body. The guides shall be as deep and as long as possible, but not protruding into the flow path to offer support in all gate positions.

The rubber coated gate shoes shall accurately fit the body guide profile to allow smooth operation of the gate with minimal shudder.

### **PSVA 6.9.2 Gate**

The gate shall be accurately moulded and completely encapsulated in rubber to ensure drop tightness over the valve pressure range. The rubber coated gate shall be designed to offer an equal distribution of sealing pressure in all directions with a capacity to accept foreign matter up to 1mm in particle size.

|  |  |  |  |  |  |
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### **PSVA 6.9.3 Stem**

A corrosion resistant stem seal arrangement shall include a scraper ring to prevent the ingress of foreign matter. A stem thrust collar shall be installed between anti-friction materials to ensure low operating forces.

### **PSVA 6.9.4 Sealing faces**

Body and gate seals shall be of such design and construction that will prevent seals becoming loose and prevent water passing behind seals under all conditions of operation and test. This feature must be proven at tendering stage by suitable drawings and documentation.

### **PSVA 6.9.5 Position indicators**

All valves of DN 300 and larger shall, except where otherwise specified, be fitted with mechanical indicators to show the position of the gate.

### **PSVA 6.9.6 Gate and body marks**

One face of the gate shall be marked, corresponding to a similar mark on the body, to ensure correct replacement after dismantling. The marks shall be visible and clear after coating.

## **PSVA 7 BUTTERFLY VALVES**

### **PSVA 7.1 GENERAL**

Butterfly valves shall be manufactured to the nominal bore, class, and working pressure as detailed in the Project specification or Schedule of Quantities and shall comply with the following requirements:

Butterfly valves shall be either of the seal in body or the seal in disc type as detailed in the Project specification or Schedule of Quantities. Butterfly valves with nominal bore not exceeding 450mm shall be of the wafer or flanged type as specified in the Project Specification. Valves larger than 450mm ND shall be of the flanged type.

All seal in disc Butterfly valves shall be of the double eccentric, bi-directional, full-bore and "tight shut off" type. Manufacturers shall certify that seal in disc valves are of the double eccentric design. All butterfly valves shall seal and be pressure tested from both directions.

The maximum flow rate in the valves shall not exceed 7 m/s unless otherwise specified. The maximum permissible flow rates through the valves at the respective maximum differential pressure across the valve shall be quoted. No cavitation in the fully open position shall be accepted and the tenderer must state the head loss for the specified flow rates in his covering letter.

Butterfly valves shall be generally in accordance with BS 5155. Face-to-face shall be in accordance with BS 5155 for pressures up to and including PN 25, whilst for PN 40 face-to-face may be to DIN 3202.

### **PSVA 7.2 MANNER OF OPERATION**

#### **PSVA 7.2.1 General**

Butterfly valves shall be operated by hand or by electric actuator as specified. Actuator mounting flanges shall conform to ISO 5211.

The valves shall be capable of closing under the maximum head and maximum specified flow rate. The valves shall be capable of operating in any position without variation of the disc position or flutter.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

There shall be no interference in the water flow pattern through a valve, i.e. the disc stop mechanism shall not impede the flow pattern. No cavitation in the fully open position shall be accepted.

Discs shall close with a positive action with no possibility of slamming shut during any stage of the closing operation. All valves shall be installed in a position that allows the valve to operate along the horizontal axis. The lower portion of the disc shall open towards the downstream side of the valve i.e. in the direction of flow.

#### **PSVA 7.2.2 Valve rotation**

Unless otherwise specified in the Scope of Works, butterfly valves shall, where applicable, be closed by turning a handwheel clockwise when seen from above the spindle.

The direction of opening of the valve shall be clearly indicated on the actuator of the valve. A robust cast iron or steel indicator shall be provided to indicate the position of the valve.

#### **PSVA 7.2.3 Opening and closing torque**

The opening or closing torque on the handwheel, where fitted in accordance with the requirements of the Scope of Works, shall not exceed 300N when operating against an unbalanced head equal to the maximum rated working pressure of the valve or when operating against a lower pressure where so stated in the Scope of Works.

#### **PSVA 7.2.4 Sealing ability**

Butterfly valves shall seal drop tight from both sides at all pressures up to the maximum rated working pressure of the valve.

### **PSVA 7.3 DESIGN**

#### **PSVA 7.3.1 Body**

The hubs for the shaft-bearings and the gearbox mounting flanges shall form an integral part of the valve body. A 10 millimetre wide and 5 millimetre deep drain groove shall be machined in the gearbox mounting flanges to release any seepage water in the event of shaft seal failure.

#### **PSVA 7.3.2 Shafts**

The valve shall be suitable for installation with the shaft in any position.

Shafts can be either continuous or a stub-shaft design configuration. Stub-shafts shall extend into the disc hub for a distance of at least 1.5 x shaft diameter and shall not protrude from the hubs i.e. exposing the shafts.

The shaft shall have a splined or square shaft connection to the disc and shall be of single piece construction, supported both at the bottom and top of bearings and isolated from the liquid being conveyed through the valve. Shafts may also be attached to the blade by means of keys, at the Engineer's discretion. Shaft fixing by means of dowel or taper pins shall not be accepted.

O-ring seals shall be used only as dust seals and not as primary sealing devices..

The shaft connection shall be designed to transmit shaft torque equivalent to at least 75% of the torsional strength of the shaft.

The shaft shall be positively connected inside the disc. The control shaft shall be connected to the spindle by means of a through-bolt.

#### **PSVA 7.3.3 Disc**

The disc shall be a single casting or fabrication with a smooth continuous surface.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The disc of seal in body valves shall be of hydrofoil section with a smooth continuous surface and shall be manufactured in 316L stainless steel.

The maximum combined stresses in the disc shall not exceed 20% of the minimum yield stress of the material used, when an unbalanced (differential) pressure equal to the maximum rated working pressure of the valve is applied to either side of the valve.

The disc shall be connected to the shaft by means of corresponding splines or square shaft. Keys may be accepted at the Engineer's discretion but pins, bolts or other devices shall not be accepted.

#### **PSVA 7.3.4 Seal retaining rings**

Stainless steel seal retaining rings shall be coated to reduce galvanic corrosion. Any recess for the retaining ring in the disc or body shall be coated and the retaining rings assembled whilst the coating is still wet. The coating may be brush applied 2- pack epoxy approximately 150 DFT or FBE. The recess for the retaining ring/s in the blade or body shall be coated in accordance with the corrosion protection specifications, or the seal face shall be assembled with a coat of wet solvent free epoxy.

#### **PSVA 7.3.5 Seats and seals**

Preference shall be given to a resilient seal arrangement that is removable, replaceable and adjustable in situ from the down stream side of the valve without having to remove the valve from the pipeline.

The resilient seals shall have non-weathering, non-sticking, long life properties and shall be compatible with the quality of the water to be conveyed. Resilient seals shall be continuously molded soft seals without joints. Glued seals are not acceptable.

The edge of the seal retaining groove in the disc shall be stainless steel 304L deposit welded before machining for an O-ring or music note type seal.

Sealing faces in the body, weld deposited or replaceable, shall be accurately machined and polished and shall provide adequate "lead in" for the resilient seal to open and close on the stainless steel seat only.

The mounting flange of a removable seat in the body shall either be stainless steel deposit welded and machined level with the seat, or the seat ring shall be manufactured to cover the seat mounting flanges.

The seat and seal shall be of a design preventing them from becoming loose and obviate water seepage under the seals or seats during all conditions of operation and testing.

#### **PSVA 7.3.6 Body liner**

The body liner of seal in body valves shall be of the full body liner type with an EPDM liner and shall be either removable or vulcanised, as detailed in the Project Specification.

#### **PSVA 7.3.7 Bearings**

Self lubricating sleeve type bearings (bronze backed) or bushes shall be fitted into the hubs of the valve body. Each valve shall be fitted with at least one adjustable thrust bearing or spacer disc set to hold the disc securely concentric with the body or seat.

#### **PSVA 7.3.8 Lubrication**

All points on the valve requiring lubrication shall be fitted with nipples suitable for grease gun application.

#### **PSVA 7.3.9 Limit stops**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Butterfly valves shall be fitted with adjustable mechanical limit stops to limit disc movement at the fully open and fully closed positions.

#### **PSVA 7.3.10 Position indicators**

A robust cast iron or steel indicator shall be provided to accurately indicate the position of the valve.

#### **PSVA 7.3.11 Hand wheels**

Unless otherwise specified, all Butterfly valves shall be fitted with gearbox actuators and with robust, solid disc type handwheels. The ring and spokes of the handwheel, where fitted, shall be cast or fabricated from material with a diameter of not less than 20mm. The direction of closing shall be marked on the hand wheel.

Maximum hand wheel dimensions shall be as follows:-

##### **PN16**

100 NB to 300 NB – Maximum diameters may not exceed 250mm  
400 NB to 1000 NB - Maximum wheel diameters may not exceed 400mm

##### **PN25**

100 NB to 200 NB – Maximum wheel diameters may not exceed 250mm, 250 NB to 800 NB  
– Maximum wheel diameters may not exceed 400mm, 900 NB and 1000 NB – Maximum diameters may not exceed 500mm  
Note:

Under no circumstances may the hand wheel diameters exceed those specified. Maximum rim pull on the hand wheel may not exceed 300 Newton.

#### **PSVA 7.3.12 Gearboxes**

Gearboxes shall be of the self locking worm and gear type with zero backlash. Gears shall be precision machined to ensure compliance in this regard.

Worm shafts shall be fitted with roller thrust bearings to ensure minimal operating effort and smooth rotary action of the input shafts.

Gearboxes shall be packed with approved water resisting grease. The enclosure shall conform to a minimum of IP67 to prevent the ingress of water and debris into the gearbox housing.

Gearboxes shall in all instances be sized for fitting of actuators and shall be provided with ISO mounting pads for direct actuation. Actuator mounting flanges shall conform to ISO 5211.

To prevent over travel of the valve blade in the open or closed position, all valves shall have adjustable mechanical stops incorporated in the gearbox. End stops shall be of the travelling nut type enabling precise setting of the disc open/closed positions.

Gearbox orientation shall be such that the gearboxes do not foul adjacent pipe work. The Contractor shall confirm gearbox orientation with the Engineer before placing any orders.

Full details of gearboxes in the form of a general arrangement drawing or certified catalogue information must be provided with the tender.

#### **PSVA 7.3.13 Corrosion protection coating**

The inside and outside of the valve body shall be either Rilsan coated (min. DFT 300 micron) or FBE coated (min DFT 250 micron) or an alternative coating approved by the Engineer.

#### **PSVA 7.4 CONSTRUCTION MATERIALS**

Butterfly valves shall be constructed generally in accordance with BS 5155. Valve components, unless otherwise specified in the Scope of Work, shall be constructed of the material specified in Table 4.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

**TABLE4: MATERIAL SPECIFICATIONS**

| COMPONENT                             | MATERIAL TYPE                                                 | MATERIAL SPECIFICATION                                                    |
|---------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------------------|
| Body                                  | Sg Iron Cast Steel                                            | BS 2789 Gr 420 / SABS 936 SG 42<br>ASTM A216 WCB<br>SANS 1431 Gr 300WA    |
| Disc                                  | Sg Iron Cast Steel Stainless steel                            | BS 2789 Gr 420 / SABS 936 SG 42 ASTM A216 WCB / BS 970 Part 4, Gr 304 S15 |
| Body Seat                             | Stainless Steel                                               | BS 970 Part 4, Gr 304 S15                                                 |
| Blade / Seal                          | Elastomer                                                     | EPDM 750 A                                                                |
| Seal Retaining Ring                   | Stainless Steel                                               | BS 970 Part 4, Gr 304 S15                                                 |
| Shafts                                | Stainless Steel                                               | BS 970 Part 4, Gr 431 S29                                                 |
| Shaft Bearings / Bushes               | Phosphor Bronze Sleeve Type<br>PTFE Backed / Self Lubricating | BS 1400 PB1C (Cu, Sn10, P)<br>Bronze Backed (DUB) GLACIER DU              |
| Shaft Seals                           | Radial Lip Seal / Cup Seal / O-Ring Seal Elastomer            | NITRILE / VITON NBR                                                       |
| Idle Shaft Thrust Bearing/Spacer Disc | Phosphor Bronze                                               | BS 1400 PB1C (Cu, Sn10, P)<br>(for vertical installations)                |
| External Fasteners                    | Stainless Steel                                               | ASTM A193 Gr B8M, ASTM A439 Gr D2                                         |
| Internal Fasteners                    | Stainless Steel                                               | ASTM A193 Gr B8M, ASTM A439 Gr D2                                         |

*The supplier shall provide full details of materials used in the valve construction.*

## PSVA 7.5 ACTUATORS

Butterfly valves with a nominal bore not exceeding 150mm may be operated directly or by actuator as specified in the Scope of Works.

Butterfly valves exceeding 150mm nominal bore shall be operated by hand (geared actuator), electric, pneumatic or hydraulic actuator as specified in the Scope of Works conforming to the following requirements:

- Actuators shall not be an integral part of the main valve body but shall be a separate unit bolted to the main body in such a manner that water leaking past the main shaft seal is prevented from entering the actuator;
- Actuator mounting flanges shall conform to ISO 5211;
- Positive, adjustable, limit stops shall be provided to prevent over opening or over closing of the valves;
- All actuators are to be geared such that the valve cannot be opened or closed in less than 3 minutes unless otherwise stated in the Project specification;



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



- e) Hand operated actuators with a gear ratio of 2 : 1 or lower shall be provided with an easily replaceable shear key to prevent damage to the valve if excessive force is applied on the hand-wheel in the fully open or closed position;
- f) Actuators shall be of such a design that the disc will be held in any fixed position for an extended period of time;
- g) Electrically operated actuators shall be fitted with a hand operated override for use in case of power failure;
- h) Pneumatic and hydraulically operated actuators operation details shall be as specified in the Scope of Works.

## **PSVA 7.6 END CONNECTIONS AND JOINTING**

Valves shall be either double flanged or wafer type as scheduled.

### **PSVA 7.6.1 Flanged valves**

Unless otherwise specified in the Scope of Works, flanges shall be drilled off centre and in accordance with the requirements of SANS 1123.

Tapped holes are unacceptable except where stiffening ribs interfere with bolting. The front faces of all flanges shall be fully machined.

Flanged valves shall be supplied complete with all jointing material such as gaskets, bolts, nuts and washers necessary for both flanges.

Bolts are to be of such length that, when the valve is bolted to or between steel flanges with thickness as per SANS 1123, between zero and two threads protrude past the nut.

### **PSVA 7.6.2 Wafer valves**

The dimensions of wafer valves shall be such that the valves may be fitted between flanges complying with the dimensions set out in SANS 1123 for the pressure table scheduled.

## **PSVA 7.7 DATA PACKS**

All valves shall be supplied with comprehensive Data Packs containing the following:

- a) Actual mill material certificates for all components;
- b) Coating certificates indicating details of coating type used and results of actual thickness tests conducted to conform to minimum coating requirements as specified. (This may include Pin Hole Detection)
- c) Pressure test certificates for the body and seal;
- d) As built general arrangement drawings of the valve and gearbox;
- e) Operating and Maintenance manuals.

## **PSVA 7.8 WARRANTY**

All valves supplied must include a 15-year warranty, fair wear and tear excluded and the company tendering must submit information to substantiate their claim that such a guarantee is possible and will be honoured. Details of contactable references that can verify the service backing and performance of the valves offered must be provided.

## **PSVA 8 NON-RETURN VALVES**

### **PSVA 8.1 GENERAL**

The Non-return valves for this project shall be 1200Ø mm Nozzle Type check valve designed, manufactured and tested in accordance with relevant local or international specifications.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



Non-return valves shall be of the nominal bore, class, and working pressure as detailed in the Bill of Quantities.

Unless otherwise indicated in the Scope of Works, non-return valves with nominal bore not exceeding 300mm may be of the sloping seat single swing door type or spring assisted single or multiple door type.

## PSVA 8.2 MANNER OF OPERATION

Non-return valves shall close at such a rate and in such a manner as to impose a minimum water hammer on the pipeline.

## PSVA 8.3 MATERIAL

| Item Name   | Material                                                      | Description              | EN Standard        |
|-------------|---------------------------------------------------------------|--------------------------|--------------------|
| Inlet Body  | GGG 40                                                        | Ductile Iron             | EN-GJS-400-15      |
|             | GGG 50                                                        |                          | EN-GJS-500-7       |
| Outlet Body | GGG 40                                                        | Ductile Iron             | EN-GJS-400-15      |
|             | GGG 50                                                        |                          | EN-GJS-500-7       |
| Disc        | GGG 40                                                        | Ductile Iron             | EN-GJS-400-15      |
|             | GGG 50                                                        |                          | EN-GJS-500-7       |
|             | 304                                                           | Stainless Steel Casting  | G - X6CrNi 18-9    |
|             | 316                                                           |                          | G - X6CrNiMo 18-10 |
|             | CC 331G-GS                                                    | Aluminium Bronze         | CuAl10Fe2-C        |
| Ring        | NBR - EPDM                                                    | Rubber                   | -                  |
| Bolts Nuts  | Galvanized                                                    | Steel                    | -                  |
|             | A2 - A 4                                                      | Stainless Steel          | -                  |
| Shaft       | 420                                                           | Stainless Steel          | X20Cr13            |
|             | 304                                                           |                          | X5CrNi 18-10       |
|             | 316                                                           |                          | X5CrNiMo17-12-2    |
| Bearing     | Rg 5                                                          | Bronze                   | G-CuSn5Zn5Pb5-C    |
| Spring      | 301                                                           | Stainless Steel          | X 12 CrNi 17-7     |
| Body Seat   | 316 L                                                         | Stainless Steel Welding  | 12072              |
|             | CuAl8                                                         | Aluminium Bronze Welding | 14640 S Cu 6100    |
| Disc Seat   | 316 L                                                         | Stainless Steel Welding  | 12072              |
|             | CuAl8                                                         | Aluminium Bronze Welding | 14640 S Cu 6100    |
| Coating     | WRAS approved fusion bonded epoxy 300 microns dft as standard |                          |                    |

## PSVA 8.4 END CONNECTIONS AND JOINTING

Valves shall be double flanged be drilled off centre and in accordance with the requirements of the Table 2500 in the latest edition of SANS 1123



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

## PSVA 9 AUTOMATIC CONTROL VALVES

### PSVA 9.1 GENERAL

Automatic Control valves shall be used for the following applications:

- Pressure reducing valve
- Pressure sustaining valve
- Check valve
- Flow control
- Level Control
- Pump Control
- Altitude valve

Automatic Control valves shall be hydraulically operated, pilot actuated for the specified application as given in the Bill of Quantities.

The design of the valve shall be of two components, namely a single cast body and an elastomeric liner.

### PSVA 9.2 MANNER OF OPERATION

Automatic control valves shall not chatter or slam under low flow conditions. Accurate pressure and flow control shall be obtained under all flow conditions.

Pressure reducing valves shall lower downstream pipeline pressure to a pre-determined pressure, at all flow rates regardless of changes in inlet pressure.

The valve shall be pilot-controlled by means of a double-acting diaphragm valve.

### PSVA 9.3 CONSTRUCTION MATERIALS

Automatic control valves shall be constructed using materials as follows.

|                                 |                                                                                                                    |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b><u>Body:</u></b>             | Ductile Iron, Austenitic Cast Iron or Cast Steel – Rilsan Coated (min. DFT 300 micron) or FBE (min DFT 250 micron) |
| <b><u>Liner:</u></b>            | EPDM, 70 durometer                                                                                                 |
| <b><u>Liner retainer:</u></b>   | Stainless Steel grade 316                                                                                          |
| <b><u>Pilot Body:</u></b>       | ASTM B62 Bronze                                                                                                    |
| <b><u>Wetted Parts:</u></b>     | Stainless steel grade 316 Control fittings                                                                         |
| <b><u>Control fittings:</u></b> | Brass                                                                                                              |

All copper/zinc alloys used must be dezincification resistant.

No galvanised fittings shall be used on any part of a valve in contact with the water.

### PSVA 9.4 FLANGE DRILLING

Flanges to automatic control valves shall be drilled in accordance with SANS 1123.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

## PSVA 10 AIR VALVES

### PSVA 10.1 GENERAL

Air valves shall fulfil the following operational functions:

- High volume air discharge during pipeline while filling;
- Large and small orifice ;
- Pressurized air release from a full operating pipeline;
- High volume air intake to prevent negative (vacuum) pressures induced while draining pipeline;
- High volume air intake to prevent negative (vacuum) pressures induced by transient pressures.
- Air valves shall have a cast SG iron body. Stainless steel fabricated body valves shall not be permitted

### PSVA 10.2 MANNER OF OPERATION

Prior to the ingress of water into the air valve chamber when the pipeline is being filled, air valves shall vent through the large orifice up to a transient pressure rise of 2 x valve rated pressure.

Air valves shall not exhibit leaks of weeping of water past the large orifice seal for an operating pressure range from 0.5 bar to 2 x rated working pressure.

The valve shall respond to the presence of air by discharging air through the small orifice at any pressure from 0.5 bar to the rated pressure. The valve shall remain leak tight in the absence of air.

The valve shall react immediately to the pipeline drainage or water column separation by the full opening of the large orifice to allow unobstructed air intake at the lowest possible negative internal pipeline pressure. The valve shall not slam.

### PSVA 10.3 DESIGN

#### PSVA 10.3.1 Large diameter air valves

Large diameter air valves shall be of the compact single chamber design with solid cylindrical HDPE control floats housed in a cylindrical stainless steel body with flanged inlet and outlet stainless steel orifice plates secured by means of stainless steel tie rods.

The valve shall incorporate an automatic air release "Anti-Shock" and vacuum break features to prevent pipeline damage resulting from high induced transient pressure surges to 2 x valve rated working pressure.

The intake orifice area shall be equal to the nominal size of the valve.

Large orifice sealing shall be affected by the flat face of the control float seating against a Nitrile rubber O-ring housed in a dovetail groove circumferentially surrounding the orifice or the sealing of a ball against a supported sealing ring.

Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal fixed into the control float.

Flanged ends shall be supplied complete with the required number of stainless steel screwed studs, including nuts, washers and jointing gaskets.

Note that alternate designs may be considered if their performance is equivalent and they have a price advantage.



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### **PSVA 10.3.2 Small diameter air valves**

Small diameter air valves shall be capable of exhausting large volumes of air at controlled rates without slam and be able to exhaust small volumes of air while under pressure. These valves shall be available with stainless steel or nylon reinforced bodies with a small orifice of at least 12mm<sup>2</sup> and a large orifice of at least 800 mm<sup>2</sup>.

### **PSVA 10.4 CONSTRUCTION MATERIALS – LARGE DIAMETER AIR VALVES**

|                       |                                   |
|-----------------------|-----------------------------------|
| Body:                 | Ductile or SG iron                |
| Dirt screen:          | Stainless steel grade 304         |
| Floats:               | HDPE , Stainless Steel or similar |
| Orifice Plate ends:   | Stainless steel grade 304         |
| Small orifice nozzle: | Stainless steel grade 304         |
| Joint Gaskets:        | EPDM                              |
| Seat seals:           | EPDM                              |

### **PSVA 10.5 TESTING**

All air release valve shall be subject o the following test procedures:

- High pressure strength and leak test where the valve shall be filled with water and pressurised to 2 x rate pressure. The pressure shall be maintained for a minimum of two minutes without any leaking, weeping or sweating.
- Low head, low pressure leak test where the valve shall be filled with water and pressurised to a maximum of 0.5 bar using a visible water column. The valve shall be rejected should leak tightness not be maintained for a minimum of two minutes.
- A vacuum break test (drop test) shall be performed by filling the valve with water, pressurised to the rated pressure and then isolated. Pressurised air shall be admitted into the valve while maintaining the pressure in the valve to a minimum of 2 bar above the rated pressure. The “Drop Test” is carried out by slowly bleeding the pressure in the valve until the rated pressure is reached. Should the float not drop to release the pressurised air, the valve will be rejected.

### **PSVA 11 ITEMS APPLICABLE TO ALL VALVES**

#### **PSVA 11.1 JOINTING MATERIAL**

Gaskets shall be made from asbestos-free gasket material and made in accordance with BS 281 Grade B with a minimum thickness of 3,0 mm.

#### **PSVA 11.2 CORROSION PROTECTION COATING**

All valve components manufactured from mild steel or ductile iron shall be internally and externally coated with a heavy duty corrosion protection system such as Rilsan coating or FBE.

#### **PSVA 11.3 PREVENTION OF ELECTROLYSIS**

Where the construction of the valve is such that it is impossible to avoid dissimilar metals of which the potential difference exceeds 0,3 volts, suitable insulation material shall be used on the contact faces between such dissimilar metals.



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## PSVA 11.4 TOLERANCES

### PSVA 11.4.1 Body Dimensions

The dimensions of the body of each valve and its component parts shall comply with the relevant tolerance requirements of Table below and of the applicable standard specification for the valve.

| Face-to-face dimensions mm        | Tolerance mm |
|-----------------------------------|--------------|
| Up to and including 200           | +/- 1        |
| Above 200 up to and including 400 | +/- 2        |

### PSV 11.4.2 Flanges and couplings

Flanges shall be subject to the following tolerances:

Outside diameter of flange:  $\pm 3$  mm

Thickness of flange:  $\pm 1$  mm

Diameter of bolt circle:  $\pm 1$  mm

Couplings shall be subject to the tolerances specified in the appropriate standard specification.

### PSVA 11.4.3 Commissioning

After commissioning each valve shall perform in the manner, and within the limits and tolerances required in terms of the Project Specification.

## PSVA 11.5 DELIVERY

Valves are to be delivered to and off-loaded at a site specified in the Project Specification by the valve supplier unless otherwise indicated in the Project Specification.

The cost of such delivery and off-loading is to be included in the cost of the valves.

## PSVA 12 MEASUREMENT AND PAYMENT

The manufacture, testing, supply, delivery, installation and commissioning of all valves shall be scheduled separately per valve type, size, working pressure and other relevant data.

The rate shall include for the cost of manufacture, quality control, supply, testing (where applicable), corrosion protection, crating, delivery and off-loading on site, storage and fixing in position as directed, commissioning, including all bolts, gaskets and accessories as required.

### C3.6.3 PSM&E – MECHANICAL, ELECTRICAL AND C&I REFURBISHMENT AND UPGRADE (OWTW)

| SEC       | DESCRIPTION                                                              | PAGE    |
|-----------|--------------------------------------------------------------------------|---------|
| PSM       | PARTICULAR SPECIFICATIONS FOR MECHANICAL REFURBISHMENT AND UPGRADE WORKS | C3.10-4 |
| MECH 0001 | GENERAL MECHANICAL REQUIREMENTS                                          | C3.10-5 |



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| SEC        | DESCRIPTION                                                                               | PAGE      |
|------------|-------------------------------------------------------------------------------------------|-----------|
| MECH 0002  | OPERATING AND MAINTENANCE MANUAL                                                          | C3.10-47  |
| MECH 1003  | LIFTING EQUIPMENT                                                                         | C3.10-54  |
| MECH 7023  | PIPE COUPLINGS                                                                            | C3.10-91  |
| MECH 7024  | PIPEWORK SUPPORTS                                                                         | C3.10-94  |
| <b>PSE</b> | <b>PARTICULAR SPECIFICATIONS FOR ELECTRICAL REFURBISHMENT AND UPGRADE WORKS</b>           | C3.10-119 |
| PSE - 04   | PARTICULAR SPECIFICATION FOR LOW VOLTAGE SWITCHBOARD AND MOTOR CONTROL CENTRES            | C3.10-166 |
| EPS - 01   | LOW VOLTAGE ELECTRICAL MOTORS                                                             | C3.10-207 |
| EPS-02     | LOW VOLTAGE ELECTRICAL CABLE RACKS                                                        | C3.10-220 |
| EPS-03     | ELECTRICAL ISOLATOR PUSHBUTTON STATION (LOCAL START/STOP) EQUIPMENT                       | C3.10-228 |
| EPS-04     | ELECTRICAL LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES                             | C3.10-232 |
| EPS-05     | ELECTRICAL EARTHING AND LIGHTNING PROTECTION                                              | C3.10-253 |
| EPS-06     | ELECTRICAL LOW VOLTAGE AND CONTROL CABLES                                                 | C3.10-264 |
| EPS-07     | ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKETS OUTLETS                         | C3.10-268 |
| EPS-010    | ELECTRICAL UNINTERRUPTIBLE POWER SUPPLY UNIT                                              | C3.10-309 |
| EPS-011    | PARTICULAR SPECIFICATION FOR INSTRUMENTATION                                              | C3.10-316 |
| PSCI       | PARTICULAR SPECIFICATIONS FOR CONTROL AND INSTRUMENTATION REFURBISHMENT AND UPGRADE WORKS | C3.10-335 |

## PSM: PARTICULAR SPECIFICATIONS FOR MECHANICAL REFURBISHMENT AND UPGRADE WORKS

### SPECIFICATION: MECH 0001 - GENERAL MECHANICAL REQUIREMENTS

#### 1. Scope

Mech 0001 specifies general technical requirements for contracts in which the Contractor is responsible for the detailed design.

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## 2. Normative References

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Mech 0001).
- b) Mech 0003: General Corrosion Protection for Pipelines, Water Treatment Works and Pump Stations.
- c) Mech 7001: Design and Manufacture of Medium Pressure Steel Specials.
- d) Mech 7024: Pipe Supports.

The following South African National Standards are referred to in this specification:

- SANS 200
- SANS 936/7
- SANS 989/992
- SANS 1034
- SANS 1062
- SANS 1123
- SANS 1186
- SANS 1200H
- SANS 1465
- SANS 1700
- SANS 10044
- SANS 10104
- SANS 10160
- SANS 10108
- SANS 10268
- SANS 12944
- SANS 15874
- SANS 50025
- SANS 60034
- SANS 61241
- SANS/ISO 4427

The following British Standards are referred to in this specification:

- BS 1400
- BS 1452
- BS 1490
- BS 2035
- BS 2789
- BS 3100
- BS 3790
- BS 4515
- BS 4872

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- BS 7854
- BS EN 681
- BS EN 1092
- BS EN ISO 23936

The following German Standard(s) are referred to in this specification:

- DIN 17 445

The following ISO standards are referred to in this specification:

- ISO 4184
- ISO 10816

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

The following British Standards are referred to in this specification:

### **3. BS 14 Materials**

#### **3.1 General**

All materials used in the manufacture and construction of plant and equipment shall be new and unused. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and corrosive environments.

#### **3.2 Steel**

Structural steel shall comply with the requirements of SANS 50025 for grade S 355 JR or for grade S 355 JO.

#### **3.3 Stainless Steel**

##### **6.15.3 General**

The grade of stainless steel to be used shall be as specified. Rolled material shall be supplied with a matt, annealed and pickled or otherwise de-scaled surface finish.

Where grades EN Grade 1.4401 (316) and EN Grade 1.4301 (304) are specified, these shall be taken synonymously with the low carbon grades for welding.

If stainless steel is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

##### **6.15.4 Certification**

The Contractor shall provide spectroscopic analyses of stainless steel materials. The analysis shall be undertaken by a local materials laboratory and shall be submitted to the Engineer.

Stainless steel supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

#### **3.4 3CR12**

This is the titanium stabilised, 12 % chrome steel. It shall be supplied with an annealed and pickled finish.

If 3CR12 is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

#### **3.5 Plastics**

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

PVC is regarded as too brittle and shall not be used unless called for in this Specification or approved in writing



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by the Engineer before supply.

### 3.6 Castings

Castings shall comply with the relevant South African or international standard for the material used, including the following:

- |                           |                       |
|---------------------------|-----------------------|
| • Grey Cast Iron          | SANS 1034; BS 1452    |
| • S. G. Iron              | SANS 936/7; BS 2789   |
| • Steel (General Purpose) | SANS 1465; BS 3100    |
| • Aluminium               | SANS 989/992; BS 1490 |
| • Stainless Steel         | DIN 17 445            |
| • Copper and Copper Alloy | SANS 200; BS 1400     |

Castings shall be clean and sound and shall be neatly fettled and dressed. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity, inclusions and sharp edges will not be tolerated.

Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area, and sufficient space shall be provided for the use of ring or socket spanners.

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

No repairs shall be undertaken to castings without the written permission of the Engineer. Cast iron castings shall not be welded.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size, and to provide maximum corrosion resistance. The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

## 4. Fabrication of Carbon Steel and Stainless Steel

### 4.1 General

Steelwork shall generally be constructed, fabricated and erected in accordance with the applicable requirements of SANS 1200 H.

Welding shall comply with the clause "Welding".

Sharp edges, pits, inclusions, weld spatter, undercuts, indentations or other surface defects are not acceptable.

Edges shall be rounded to a radius of at least 2 mm. Designs shall avoid inaccessible pockets and hollows.

Sharp edges on items fabricated from thin sheets will not be acceptable and sharp edges shall preferably be avoided by good design.

Inspection of fabrications shall generally be done after fabrication is complete.

### 4.2 Carbon Steels

Structural steelwork shall be of grade S 355 JR or of grade S 355 JO in accordance with SANS 50025.

The requirements of the Hot Dip Galvaniser's Association of South Africa shall be complied with if the item is to be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the molten zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided.

Surfaces to be coated shall be accessible by blast and spray equipment. Inaccessible pockets, such as bad weld profile as well as hollow structures, are unacceptable and the angle of impact of blast material and sprayed coatings shall not be less than 45 degrees. Edges shall be rounded for safety reasons and also to be suitable



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for the coating system to be applied.

#### 4.3 Austenitic Stainless Steels

Fabrication of austenitic stainless steels shall comply with the recommendations in "The Stainless Steel User Manual" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steel fabricators shall use permanently dedicated storage and fabrication areas and shall use machines, tools and handling equipment which are suited and permanently dedicated to this type of material.

Fabrications shall be pickled and passivated over their full surface to achieve an even colour. If grinding is required before pickling, the final grinding shall be done with a fine disc in order to remove coarse grinding marks.

#### 4.4 3CR12

Fabrication of 3CR12 shall comply with the requirements for austenitic stainless steels except that the recommendations in "The 3CR12 Fabrication Guide" issued by Columbus Stainless shall be used. Compliance with publications from equivalent authorities will be acceptable.

#### 4.5 Highly Alloyed Stainless Steels

Fabrication of duplex, super austenitic and other highly alloyed stainless steels shall follow the metal producer's own guidelines.

Welding of duplex stainless steel pipework shall be in accordance with BS 4515 Part 2 or equivalent.

### 5. Welding

#### 5.1 Standards

Standards complying with good modern practice, and acceptable to the Engineer, shall be adopted and the recommendations of the SAIW are acceptable in this respect.

Welders shall be experienced artisans approved in accordance with BS 4872 or equivalent.

#### 5.2 Continuous Welding and Elimination of Crevices

Welding shall be continuous on all sides of any joint. Designs which do not allow this shall be re-designed.

Crevice, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be approved in writing by the Engineer. The resulting crevices shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmaline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.

#### 5.3 Weld Appearance

Welding shall be free of blowholes, projections, pinholes, splatter and undercuts and all welding flux, weld spatter and other sharp imperfections shall be removed. Weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground.

#### 5.4 Site Welding

Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.



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## 5.5 Welding of Stainless Steel and 3CR12 – Additional Requirements

Fabrication of austenitic stainless steels and 3CR12 shall comply with the recommendations in "The Stainless Steel User Manual", "The 3CR12 Fabrication Guide" and the general welding requirements in "Pocket Guide – Stainless Steels" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steels to be welded shall be of the low carbon grade; e.g. 1.4306 rather than 1.4301 and 1.4404 rather than 1.4401.

The welding rods used shall be the most suitable for the metal and purpose. Only welders experienced with welding stainless materials shall be used.

Welds which are accessible from only one side shall be executed in a manner to prevent heat tint or shall be post-weld treated in order to remove all traces of heat tint.

Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing. 3CR12 shall be welded as recommended in "The 3CR12 Fabrication Guide" issued by Columbus Stainless.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discoloration and steel contamination must be removed by pickling or electro cleaning as approved by the Engineer but should rather be avoided by taking the appropriate measures.

## 5.6 Inspections

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop.

## 6. Corrosion Protection

### 6.1 General

Unless stated otherwise in the contract document, corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944-2).

Corrosion protection shall comply with Mech 0003.

Corrosion protection systems used shall be suitable for an expected item life of at least 30 years in the environment for which they are designed. Corrosion protection for items which are buried or cast into concrete shall be designed for a life of 70 years.

### 6.2 Systems

The Contractor shall propose corrosion protection systems to the Engineer for review.

The preferred system for structural steelwork and gantries is hot-dip galvanised carbon steel. The preferred system for cranes is hot metal zinc spray and seal.

The preferred system for pipework internals is a solids containing barrier coating with a dry film thickness of not less than 800 microns.

The preferred system for guard rails, grid flooring, trench covers, stairways and ladders is hot-dip galvanised carbon steel (unless stainless steel is called for in the project specifications).

The preferred system for clarifier bridges and other carbon steel structures above water bodies is epoxy coated 3CR12 or hot-dip galvanised and painted carbon steel or hot metal zinc sprayed and sealed carbon steel.

### 6.3 Stainless Steel

Stainless steel pipework which is in contact with pipework or valve of other materials shall be provided with an internal coat in order to provide an electrical barrier between the stainless steel and the fluid such as 70 microns of Sigmacover 280 or equivalent. This requirement applies to puddle pipes which are cast into concrete.

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The coat shall extend over flange faces.

Stainless steel valves, strainers and other items of equipment shall be similarly coated.

## **7. Installation**

### **7.1 General**

The Works shall comply with the following:

- a) When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.
- b) The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.
- c) The Contractor is responsible for grouting work associated with the equipment and pipework to be provided in terms of the Contract.
- d) The use of more than three shims in the alignment of equipment will not be permitted. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.
- e) Corrosion protection requirements shall be carefully attended to and the requirements of Mech 0003 must be noted. All mating faces must be coated before and sealed after assembly.
- f) A small amount of a nickel based, anti-seize compound shall be applied along the full length of fastener threads before the nut is applied.
- g) Crevices which are formed between two metal surfaces shall, prior to final fastening, be filled with a suitable formable packing, Denso tape or equivalent, or with a suitable mastic or sealant.

### **7.2 Alignment of Shafts**

Shafts for drives with an output above 150 kW shall be aligned to the driven shaft as follows:

- a) Final alignment shall be done after installation and before commissioning and shall be checked in the presence of and to the approval of the Engineer. Alignment shall be sufficiently accurate to ensure that no pre-load is placed on the shaft coupling.
- b) Each motor shall be aligned to its pump by alignment specialists using laser aligning equipment with real time computer display. This shall be done after the pipework is bolted to the pump.

## **8. Civil and Building Works**

### **8.1 General Duties**

The Contractor shall be responsible for grouting pipework required to pass through walls, for all equipment grouting work, anchoring of equipment and closing of apertures associated with equipment to be provided in terms of this Contract.

The Contractor's Documents shall indicate the civil and building details required to accommodate the equipment installation; subject to and in accordance with any details shown on the drawings provided by the Employer. These details shall include plinths, foundation blocks, rebates, pockets, sleeve ducts, holes, thrust blocks, anchor fasteners and openings/box-outs for pipework passing through walls.

The Contractor shall inspect and check the related structures constructed by others for accuracy and suitability of construction and for conformance with the Contractor's documents before commencing installation and construction. No payments shall be allowed for additional costs to the Contractor resulting from a failure to check such works timeously or a failure to provide the related information in Contractor's Documents timeously.

### **8.2 Civil Contractor's Work**

The main civil and building works will be completed by others and will be mostly completed when the Contractor

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is granted access to the Site.

### 8.3 Puddle Pipes

The Contractor shall install the puddle pipes required by the design into concrete structures. For this purpose, the Contractor shall provide the details of box-outs required in the structure to the Engineer. Puddle flanges shall be of the same dimensions as standard flanges and the box-out shall be designed accordingly and with allowance for civil tolerances of  $\pm 40$  mm.

Concrete structures will generally be constructed by others and, if required, it will be tested for water tightness by the Engineer before handover to the Contractor by temporary closure of the box-outs.

Upon receiving access to the Site, the Contractor shall install the pipework and shall grout the puddle pipes into the structure using a suitable non-shrink grout to the approval of the Engineer. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

### 8.4 Base Frames, Pipe Supports, etc.

The design requirements for base frames and pipework supports are specified elsewhere in Mech 0001.

The Contractor shall be responsible for grouting of base frames, pipe supports, plinths, etc. required for installation of the equipment and this includes any metallic structure which is mounted onto a concrete surface.

The method proposed for anchoring base frames, pipe supports, etc. to concrete shall be submitted to the Engineer for approval and shall incorporate the details of the grout proposed. The material used for the primary grouting of the anchors shall be a non-shrink, cementitious grout such as ABE Duragrout 1000, or equivalent. ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required.

The secondary grout shall be applied only after each anchor fastener has been tested for integrity. The design and grouting shall eliminate collection points for water or dirt. If called for by the Engineer, the initial grouting shall be overseen by the grout supplier's technical representative.

## 9. Pipework Supports

Supports for steel pipework and for plastic pipework shall comply with Mech 7024.

## 10. STEEL PIPEWORK; DN 150 AND LARGER

### 10.1 General

Design and manufacture of steel pipework which is DN 150 or larger shall comply with Mech 7001: Design and Manufacture of Medium Pressure Steel Specials.

This clause specifies additional requirements for pipework which is associated with equipment installations. It applies to carbon steel pipework and to stainless steel pipework.

### 10.2 Pipework Construction and Configuration

Pipework shall be joined using bolted flanges.

Stainless steel and 3CR12 pipes shall be to ASTM A312, ANSI B36.19 or ANSI B36.10 or equivalent.

Pipes and fittings shall be neatly installed, straight to line and level and adequately supported.

Pipework shall be supported above floor level on supports, racks or wall mounted and shall not be installed directly on the floor.

Pipework shall be configured and shall be provided with couplings and/or bends to allow easy dismantling and disassembly of all pipework without damage to the pipework or pipe supports.

Provision shall be made for draining all sections of pipework. Provision shall be made for venting high points

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of pipework.

Valves shall be mounted in horizontal pipework unless this is not feasible. Pipework shall be correctly anchored to withstand thrust.

If the physical configuration does not provide axial restraint of pipework couplings, then these couplings shall be provided with thrust restraints.

Bends shall preferably be of the long radius type. 90 degree "lobster back bends" shall have a minimum of five segments. Each flange shall be perpendicular to the segment to which it is welded.

Convergences shall preferably be of swept tee formation rather than tee pieces.

### 10.3 Sump Suction Pipework

#### 10.3.1 General

Two mechanical couplings shall be provided on each pump's suction pipework. Rubber tyre type couplings are acceptable for pump inlets of DN 100 and smaller.

Suction side pipework shall have a pressure rating which is greater than the operating pressure of the pumping system.

Air leaks shall be prevented.

#### 10.3.2 Hydraulics

Pump suction pipework shall comply with good hydraulic design. The flow at each pump inlet shall have a steady, uniform pattern. The pipework shall be sized to ensure that the flow speed is no higher than 1,5 m/s except for the final pipe which shall be a straight pipe of the same diameter as the pump inlet and with a length of at least five times its diameter.

The configuration shall ensure equal flow to each operating leg, regardless of the number of pumps operating. The speed of flow in the suction manifold and into each leg shall be as low as feasible.

Suction manifold tee-offs shall be of swept tee formation if the nominal speed of flow in the leg at the tee-off is 0,7 metres per second or higher. The suction manifold tee-offs may be a normal tee formation if the nominal speed of flow in the leg at the tee-off is lower than 0,7 metres per second.

Suction pipework shall be level or shall slope upwards toward the pump. High points shall be avoided in positions where the flow speed is below one metres per second.

Bell mouths shall be mounted between 0,3D and 0,5D above the sump floor. All bell mouths in a single sump shall be mounted at the same height.

Flow straighteners shall not be used if there is a probability that the straightener will capture solids.

### 10.4 Pump Discharge Pipework

Two mechanical couplings or one rubber tyre type coupling shall be provided on each pump's discharge pipework.

#### 10.5 Reducers

Reducers shall have a maximum angle of divergence of 10° unless otherwise shown on the drawings.

Reducers shall not have more than two longitudinal weld seams.

The taper shall not be welded directly to the flange; i.e. a short cylindrical length of pipe shall be provided between the taper and each flange.

#### 10.6 Nozzle / Sockets

Nozzles shall be provided for the installation of gauges, transmitters, drain pipes, cooling water take offs, air release valves, etc.

In carbon steel pipework, nozzles shall be designed so that the pipework corrosion prevention system can be



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correctly applied to all wetted surfaces. Nozzles shall consist of a flanged, welded tee-off of at least 100 mm diameter, coated internally and provided with a non-corrosive blank flange, e.g. EN Grade 1.4401 (316) stainless steel. The blank flange shall be provided with tapped holes, or similar, suitable for the installation.

Stainless steel pipework shall be provided with small diameter, EN Grade 1.4401 (316) stainless steel sockets which are welded into the pipework with no crevices either externally or internally.

Nozzles on the suction side of pumps shall be designed and positioned to provide minimum interference with the flow path. Nozzles for pressure gauges and sensors shall be positioned for steady, uniform flow.

#### **10.7 Sludge Pipework**

Sludge pipework shall be provided with a rodding eye or similar arrangement at each bend in order to provide access to the inside of the pipe without dismantling the pipework.

#### **10.8 Pipework Flanges**

Flanges shall comply with SANS 1123 or BS EN 1092 unless required to match existing flanges. Raised face flanges shall be provided for pipework of PN 25 and higher.

Flange drilling shall be "off centre" unless required to match an existing flange which is drilled otherwise.

The jointing material used on flange joints shall be of a suitable rubber or compressed mineral fibre at least 3 mm thick complying respectively with BS EN 681 or BS EN ISO 23936, as applicable. Gaskets shall be full face. Properly designed O-ring seals are also acceptable.

Carbon steel flanges shall be chamfered on their outside edges, on their inside edges and on both sides of each bolt hole in order to provide a suitable surface for the coating to be applied. Stainless steel flanges shall be chamfered on their outside edges.

#### **10.9 Puddle Pipework**

Puddle pipes to be permanently cast into concrete shall be of EN Grade 1.4401 (316), or of EN Grade 1.4462 (2205 duplex), or of cast iron.

Puddle pipes shall be a straight length, flanged both ends and with a puddle flange. Adequate clearance shall be provided between the wall surface and the flanges for inserting flange bolts and for the handwheel/actuator of the isolation valve but the length shall be kept as short as feasible.

The puddle flange shall be of the same diameter of a normal flange and shall be positioned in the central plane of the wall. It shall be of the same material as the pipe. Puddle flanges shall have a plate thickness of at least half the thickness of the standard flange.

The surfaces not directly protected by encasement in concrete shall receive the full corrosion protection system. The coating shall extend about 50 mm into the concrete but the area in contact with the concrete shall otherwise be uncoated. The uncoated area shall be abrasive blasted to promote bonding.

Puddle pipes shall be cast into structures only after the Engineer has approved the Contractor's proposed method statement for the grouting process.

Refer, also, to the clause "Civil and Building Works".

#### **10.10 Pipe Couplings, Alignment and Flexibility**

Pipe couplings shall be provided where misalignment or dismantling must be allowed for and also for possible pipe movement from settlement or other cause. The coupling shall have the same or a higher pressure rating than the pipework in which it is installed.

Pipe couplings shall comply with Mech 7023.

#### **10.11 Pipework for Flow Meter Chamber**

A flange adaptor shall be provided on the upstream flange of a flow meter and a flange adaptor shall be provided on the downstream flange.

The pipework shall also make allowance for one isolation valve downstream of the flow meter.

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### 10.12 Pump Suction Bell - Mouths

Pump suction pipework which draws from open sumps shall be provided with bell mouth inlets. The bell mouth shall have an integral flange and shall be bolted to a flange on the suction pipework.

The bell mouth shall be provided with an elliptical (i.e. not segmented) profile.

The bell mouth may be of glass reinforced plastic, EN Grade 1.4401 (316) stainless steel or of cast iron.

### 10.13 Fabrication of Pipework

Fabrication shall comply with the clauses "Fabrication of Carbon Steel and Stainless Steel" and "Welding". Welding shall achieve full penetration without crevices and both internal and external weld surfaces shall have a neat profile. An internal root run shall be provided where required to achieve a neat profile.

The internal surface of pipework shall be accessible for inspection and this might require that bends, tees and bifurcations shall be short and shall not be welded to a straight pipe rather than being flanged.

### 10.14 Fabrication of Duplex Stainless Steel Pipes

Duplex stainless steel pipes shall be fabricated in an automated production pipe facility using mechanised welding procedures; i.e. they shall not be fabricated by the Contractor (or the Contractor's sub-contractor) from plate.

### 10.15 Corrosion Protection of Pipework

Corrosion protection shall comply with Mech 0003.

### 10.16 Site Works

In accordance with General Condition of Contractor 2015, the Contractor shall make allowance for the misalignment of other pipework to which the Contractor's pipework is to be connected.

### 10.17 Inspection and Testing Requirements

Where dispute arises regarding acceptance of welds, the requirements of SANS 10044 Part 3 shall be complied with.

The Contractor shall make all arrangements and carry transport and accommodation costs for the Engineer to inspect the pipework after fabrication but before any corrosion protection.

The Contractor shall perform the following (in the presence of the Engineer unless otherwise agreed):

- a) Pre-manufacturing approval of quality control documentation.
- b) 100 % dye penetrant testing of all welds.
- c) 10 % of welds to be X-rayed (this percentage will reduce if welds are found to be in order during initial testing). On discovery of defective welds the Engineer may call for radiographic examination until it is shown that the necessary standard is being maintained. Repairs of welded joints will be permitted and the repair procedure and performance of repairs shall be in accordance with Section 10 of API Specification 5L.
- d) Visual inspection of pipework.
- e) Paint thickness measurements.
- f) Pipelines which are not fully visible and/or below ground shall be pressure tested to
- g) 1,5 times maximum working pressure for at least 15 minutes without pressure loss. This shall be done before covering up the pipeline and shall be witnessed by the Engineer.
- h) Provide inspection reports.

### 10.18 Flow Velocity in Pipework



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### 10.18.1 Water

Where the pipe diameter is not specified, the design flow velocities for grit free water (water, effluent, centrate and supernatant) and for high solids water (wastewater and sludge) shall be as follows:

| DESIGN FLOW VELOCITY [m/s] |                    |                     |                     |                      |
|----------------------------|--------------------|---------------------|---------------------|----------------------|
|                            | flow = 0 - 2,5 l/s | flow = 2,5 - 15 l/s | flow = 15 - 100 l/s | flow = 100 - 500 l/s |
| grit free                  | < 0,75             | < 1,25              | < 1,5               | < 2                  |
| high solids                | 0,8 – 1,5          | 0,8 – 1,5           | 1 – 1,75            | 1 - 2                |

### 10.18.2 Air

Air flow speeds in pipework of DN 100 to DN 200 shall be approximately 20 m/s and shall not exceed 25 m/s.  
Air flow speeds in pipework above DN 200 shall be approximately 25 m/s and shall not exceed 30 m/s.

### 10.19 Steel Pipework (< DN 150 )

Steel pipework smaller than DN 150 shall comply generally with the clause above but may be of screwed rather than of flanged construction.

Air flow speeds in pipework smaller than DN 150 shall be approximately 10 m/s and shall not exceed 15 m/s.

### 10.20 Plastic Pipework

Polyethylene or Polypropylene pipes shall comply with SANS/ISO 4427 and SANS 15874 respectively and shall carry the SABS mark.

PVC pipework is not acceptable for applications involving vibration or shock, including hydraulic shock.

An operating life of 50 years shall be designed for and appropriate de-rating factors shall be applied to suit the application. The class of pipe selected shall be not less than 1,5 times the actual maximum operating pressure.

Plastic pipework installed externally shall be provided with protection against ultraviolet light.

Tappings, for example for gauges, shall be provided with welded, external doubler plates. The plates shall have a thickness at least equal to the wall thickness of the pipe.

Welding of thermoplastic pipework shall comply with SANS 10268.

### 10.21 Cast Iron Pipework

Cast iron pipes and fittings shall comply with BS 2035 (Class D) and shall be pressure tested in accordance with Clause 12 of that Standard. The requirements of the Standard's Clause 6 regarding freedom from defects and casting appearance and Clauses 8, 9 and 10 regarding casting accuracy will be strictly applied.

Cast iron pipework shall comply with the requirements of the clause "Castings".

## 11. Electric Motors Smaller than 30 KW

### Preamble

Induction motors smaller than 30 kW shall comply with this clause.

### 11.1 General Requirements

Motors shall be rated for operation on a 3-phase, 4-wire, 400/230 Volt, 50 Hz, AC supply.

Motors shall be squirrel cage motors in accordance with SANS 60034. Cooling shall be IC 0141 (similar to



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"tefc") and the motors shall be suitable for a damp environment. Ingress protection shall be IP 55 or higher. Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 °C rise capability) with a designed Class B temperature rise (80 °C). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive. A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the motor's lubrication details. If the manufacturer's nameplate does not comply with these requirements, the Contractor shall provide additional nameplates. Motors above 30 kg shall be provided with lifting eyes or lugs.

## 11.2 Performance Requirements

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 20 % in excess of the designed power requirement of the driven equipment (the Engineer might waive this latter requirement if the motor forms part of a factory packaged unit).

Motors shall be designed to provide their rated power output at an ambient temperature of up to 40 °C and at an altitude of at least 1 500 masl.

## 11.3 Operation and Control

Protection against both starting overload and running overload shall be provided.

## 11.4 VFC Driven Motors

The Contractor shall submit correspondence from the motor manufacturer/designer which confirms that the motor is designed for supply from the particular make and model of variable frequency converter to be provided in the application without shortening of the motor's lifespan.

Unless of the submersible or immersible type, VFC driven motors shall be cooled by a separate, constant speed fan (this requirement will be waived if the Contractor provides documentation confirming that the drive and motor design can operate in the application, with shaft-mounted fan, without exceeding its designed temperature rise).

Motors shall incorporate protection against damage to the bearings from induced currents.

## 11.5 Bearings

Bearings shall be of the rolling element type (i.e. ball or roller) and may be either oil or grease lubricated.

Grease lubricated bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suited for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

L-10 design life shall not be less than 100 000 hours. shall comply with the clause "Bearings" in Mech 0001.

## 11.6 Corrosion Protection

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

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## 11.7 Hazardous Locations

If the specification calls for a motor to suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

## 11.8 Safety

Rotating parts shall be guarded as required by legislation.

## 12. Electric Motors of 30 KW and Larger

### Preamble

Cage and slipring induction motors of 30 kW and above, with the exception of 3,3 kV, 6,6 kV, 11 kV and 15 kV motors, shall comply with this clause. 3,3 kV, 6,6 kV, 11 kV and 15 kV motors shall comply with the specification for MV motors.

### 12.1 General Requirements

Motors shall be in accordance with SANS 60034.

The type of motor and starter to be provided by the Contractor shall be determined by the requirements of the application specified and by any starting limitations specified. In the absence of such specifications, a squirrel cage motor shall be provided. If a special motor is required to obtain special starting characteristics and/or variable speed, this shall be to a standard at least equal to this specification and shall incorporate all aspects of electrical protection.

Motors with a rating below 1 000 kW shall be squirrel cage motors with cooling to IC 0141 (similar to "tefc"). Ingress protection shall be IP 55 or higher.

Motors with a rating above 1 000 kW shall be squirrel cage motors of CACA configuration with an ingress protection rating of at least IP 55 and shall be provided with oil lubricated sleeve bearings.

Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 °C rise capability) with a designed Class B temperature rise (80 °C). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

Wound rotor motors shall have a separate enclosure for the slip-ring assembly to ensure that dust from the slip ring followers does not enter the motor. The enclosure shall have the same ingress protection as the main motor enclosure but shall have covers for direct access. The rings shall preferably be of stainless steel.

Motors shall be structurally suitable for DOL starting regardless of the specified starting system. The frame and end covers shall locate on a spigotted register to ensure concentricity and parallelism. Motors shall be provided with lifting eyes or lugs.

An earth terminal shall be provided on the frame. Access shall be provided to the winding neutral point.

All monitored motor parameters; e.g. bearing temperature, winding temperature, current, etc.; shall be appropriately indicated.

Motors shall be of the reduced noise level type.

At least one internal cooling circuit fan shall be provided for frame sizes 355 and larger.

Motors of size 75 kW and above shall be fitted with "pocket" heaters. These shall be arranged to switch on when the motor stops operating and switch off when the motor starts operating.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the machine's lubrication details. If the manufacturer's nameplate does not comply with these requirements,



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the Contractor shall provide additional nameplates.

Measured vibration severity shall meet the requirements of Zone A or Zone B of ISO 10816. When motors are transported, care shall be taken to prevent damage to bearings.

## 12.2 Performance Requirements

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 15 % in excess of the designed power requirement of the driven equipment.

Motors shall be designed to provide this rated power output at an ambient temperature of up to 40 °C and at an altitude of at least 1 500 masl.

Motors shall reach full operating speed within 5 seconds unless driven by electronic soft start or variable speed drive.

Protection against both starting and running overload shall be provided.

## 12.3 400 Volt Motors

400 Volt motors shall be designed to operate on a 3-phase, 4-wire, 400/230 volt, 50 Hz, AC supply.

## 12.4 TEFC Motors

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

If it is specified that the motor shall produce low sound output, the fan cowl shall be provided with internal damping.

## 12.5 CACA MOTORS

The heat exchanger shall be provided with lifting eyes or lugs. Silencers shall be provided for cooling air inlets and outlets.

Rotors shall be dynamically balanced.

Ports shall be provided for air gap measurement at the drive end and at the non-drive end. Vertical jacking shall be provided at each holding down point.

## 12.6 VFC Driven Motors

Motors fed by frequency converters shall comply with the following:

- i. Motors shall be rated to allow for additional harmonic losses in accordance with SANS 60034-17. The voltage stress withstand capability of the motor shall be checked against the converter supplier's specification. The stress due to converter operation shall be lower than the repetitive voltage stress withstand capability of the motor winding insulation system.
- ii. Motors shall incorporate an insulated bearing and an earthing brush (or other approved protection against damage to the bearings from induced currents).
- iii. Motors, unless submersible or immersible, shall be cooled by auxiliary constant speed motor driven fans.

The Contractor shall submit the following to the Engineer.

- a) Confirmation that the motors comply with the requirements of SANS 60034-25 for the application.
- b) Motor manufacturer's written confirmation that the motor is suitable for drive by the VFC make and model to be provided, including confirmation that the motor's voltage withstand capability is sufficient for the voltage stresses that will occur at the motor terminals.



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- c) Guaranteed VFC harmonic performance including sample output wave forms with harmonic distortion levels at 40, 45 and 50 Hz for the VFC for the load.
- d) Guaranteed VFC dip ride through capability curve.
- e) Copy of VFC type test certificate (this is required if type tests have been carried out on the model).

## 12.7 Bearings

Bearings shall comply with the clause "Bearings" in Mech 0001.

Grease lubricated rolling element bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suitable for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

Bearings for motors of 250 kW and above shall be provided with temperature measurement, indication and alarm.

Bearings for motors in belt drive applications shall be of the rolling element type; i.e. shall not be plain bearings.

## 12.8 Instrumentation

Motors of 30 kW and up to (but not including) 150 kW shall be provided with thermistors embedded in the windings of each phase. The thermistor tails shall be "brought out" to separate terminals mounted near the motor winding terminal block.

Motors rated at 150 kW and above shall be provided with PT 100 type RTDs. Two RTDs shall be provided per phase winding. All six shall be incorporated into the control system; three to provide monitoring and three to provide high temperature trip functions.

## 12.9 Corrosion Protection

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

## 12.10 Hazardous Locations

If the specification calls for a motor for suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

## 12.11 Safety

Rotating parts shall be guarded as required by legislation.

## 13. Plinths and Base Frames

### 13.1 General

Rotating equipment shall be mounted on a metal base frame and shall not be mounted directly onto concrete.

The Contractor shall provide the base frame, anchor fasteners, grouting, chemical anchor, etc. and is responsible for all installation work, including anchoring of the base frame to the plinth.

The plinth shall be designed by the Contractor for the application. It will be constructed by others in



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accordance with the design to be submitted by the Contractor.

Equipment up to 1 000 kW shall be mounted on common base frames. This requirement applies to both direct coupled and to belt driven machines.

Separate base frames may be provided for equipment above 1 000 kW. Base frames for units of this size shall be grouted within (encapsulated in) their concrete plinths.

The Contractor shall submit the base frame workshop drawings to the Engineer for acceptance.

### 13.2 Plinths

The Contractor shall take into account all dynamic and static forces in the design of the reinforced concrete plinth and shall submit the design calculations and drawings to the Engineer for acceptance. The calculations shall confirm that the equipment's enforcing vibration will cause no resonant condition. If the plinth rests directly on soil, the calculations shall demonstrate that the design is suitable for the ground conditions without undue settlement. The design shall ensure that all forces, including the motor breakdown torque (or equivalent force if the driver is not a motor) and the torque experienced at electrical power failure, will be properly withstood.

Plinths shall comply with all of the following:

- Plinth mass shall be greater than 4,5 times the sum of the masses of the driver and the driven equipment.
- Width of plinth shall be greater than the height between the shaft centreline and the bottom of the plinth.
- Height of plinth shall be greater than one fifth of the width.
- Height of plinth shall be greater than one tenth of the length.
- Plinths for rotating equipment above 130 kW shall be isolated from the surrounding floor and other machinery plinths (this requirement does not apply to machinery which is isolated from the floor by proprietary anti-vibration mounts).

### 13.3 Sole Plates

Sole plates: i.e. plate supports for equipment feet which are individually anchored into the concrete plinth; are acceptable as base frames for equipment above 1 000 kW. They shall be grouted within (encapsulated in) their concrete plinths.

The soleplates to a depth of 50 mm within the concrete plinth/grout shall be of EN Grade 1.4401

(316) stainless steel or better corrosion resistance. Carbon steel is acceptable for portions of the soleplates with concrete cover of 50 mm or more.

The soleplate's bottom structure shall be designed so that pockets of air will not be captured under it during grouting.

### 13.4 Anchored Base Frames

#### 13.4.1 General

The base frame shall incorporate machined mounting pads for each equipment foot. The thickness of the mounting pads before machining shall be at least 1,25 times the diameter of the holding down bolts. The pads shall be drilled for inserting through-bolts (i.e. not machine screws in threaded holes) and access to the underside shall be provided for fastening.

Machining of the top surfaces of mounting pads shall be done after fabrication, stress relieving and hot-dip galvanizing are complete. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevices formed at the foot of the equipment.



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Base frame designs shall prevent pooling of water. They shall be grout filled or shall be provided with large drain holes in all side members (before corrosion protection).

Holes in the base frame and welded lugs for mounting of conduits, etc. are acceptable on condition that these are provided prior to galvanising. They shall preferably be positioned near the neutral axis of steel sections.

#### 13.4.2 Dimensions

Base frames shall have dimensions which comply with the following:

- The longitudinal member shall have a height of at least 0,095 times the length of the base frame.
- The longitudinal member shall have a height of at least 0,18 times the width of the base frame.
- Base frames fabricated from members which are cold formed from plate shall also comply with the following:
- The plate thickness shall have a thickness greater than 0.0037 times the length of the base frame (but with a minimum of 4,5 mm).

#### 13.4.3 Materials

Carbon steel base frames shall preferably be fabricated from steels complying with SANS 50025 for grade S 355 JR or for grade S 355 JO.

Base frames may also be fabricated of 3CR12 or of EN Grade 1.4162 (LDX 2101) stainless steel.

#### 13.4.4 Fabrication

Fabrication and welding shall comply with the requirements elsewhere in Mech 0001.

#### 13.4.5 Corrosion Protection

The design of the baseplate shall take into account all practical aspects of the corrosion protection system.

Accessibility for surface preparation and coating shall be provided; e.g. hidden surfaces are not acceptable; inaccessible pockets and hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed; structures to be hot dip galvanised shall provide proper access for safe and complete entry and exit of the molten zinc; etc., etc.

Carbon steel base frames shall be hot-dip galvanised in accordance with Mech 0003. Base frames which are drilled, welded or ground after galvanising will be rejected. Carbon steel surfaces which will have more than 50 mm concrete cover after grouting need not be coated.

3CR12 shall be coated with a suitable system complying with Mech 0003.

EN Grade 1.4162 (LDX 2101) stainless steel and other stainless steels need not be coated.

#### 13.4.6 Anchor Fasteners

Base frame anchor fasteners shall be of EN Grade 1.4401 (316), or better. Fasteners shall comply with the requirements for fasteners elsewhere in this specification.

Anchor fasteners for rotating equipment shall be provided with both a lock washer and a flat washer of adequate size.



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Base frame anchor fastener size shall be in accordance with the table below.

| Pump Inlet Size   | Minimum Fastener Size |
|-------------------|-----------------------|
| DN 50             | M10                   |
| DN 100            | M12                   |
| DN 200            | M12                   |
| DN 300            | M16                   |
| DN 400            | M20                   |
| DN 500            | M24                   |
| DN 600 and larger | M30                   |

The number of base frame anchors shall be in accordance with the table below.

| Pump Inlet Size | Minimum Fasteners (No.) |
|-----------------|-------------------------|
| DN 50           | 6                       |
| DN 50 to DN 150 | 8                       |
| Above DN 150    | 10                      |

#### 13.4.7 Jacking Points

Motors for both direct coupled and for belt driven equipment shall be provided with robust jacking points for alignment of the motor to the driven equipment.

Jacking screws shall be hot dip galvanised.

#### 13.4.8 Installation

Not more than three shims may be used at any point and these shall be of a corrosion resistant material.

The base frame and plinth shall form a structural unit (i.e. the base frame and plinth vibrate as a unit)



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and, to achieve this, the base frame anchors must transfer force into the concrete. It is not acceptable to provide a nut below the base frame for level adjustment as this will prevent correct anchoring.

Concrete surfaces under base frames shall be scabbled before the base frame is placed and shall be clean. Dust shall be removed from the surface by compressed air immediately before grouting.

Base frames shall be grouted in a manner which will eliminate collection points for water or dirt.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required. The first unit grouted shall be overseen by the grout supplier's technical representative.

Final equipment alignment shall be done after installation and grouting has been completed.

### 13.4.9 Inspections

The Contractor shall arrange for the Engineer to inspect the fabrication of the base frame before corrosion protection.

## 14. Machine Guards

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended.

Guards are required to cover all moving or revolving components of machinery and shall prevent a person from touching any moving protrusion. Guards which do not adequately cover moving protrusions such as keys, lock nuts, lock washers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.

Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate. Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required.

Allowance must be made for adjustment where adjustment will be required such as on belt guards. It shall be possible to remove guards easily for maintenance purposes.

Guards shall preferably be fabricated of EN Grade 1.4401 (316) stainless steel (uncoated) but may also be hot-dip galvanized, hot metal zinc-sprayed or hot metal aluminium-sprayed carbon steel, coated to Specification in all these cases. Fasteners shall be M10 or larger and shall be of EN Grade 1.4401 (316) stainless steel.

## 15. Shaft Couplings

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and the driven machine. Couplings shall, wherever practical, be of the rubber tyre or rubber compression type, keyed to the shafts.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used where required for disassembly of the equipment. It shall be possible to dismantle the coupling without having to move either the driver or the driven equipment.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

After installation, the alignment of all couplings shall be checked by the Contractor in the presence of



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the Engineer or a person delegated by him. Alignment shall be accurate and to the approval of the Engineer.

## 16. Belt Drives

Belt drives shall be designed to suit the power rating of the motor using service factors appropriate to the driving and driven machinery. Drives shall be designed, manufactured and installed in accordance with BS 3790 and ISO 4184 or equivalent, utilizing taper lock pulleys with taper locks keyed to the shaft.

Where alternative pulley diameters can be selected, preference must be given to the larger pulley diameters to minimize the belt loading on bearings.

The bearing arrangements of driving and driven machinery shall be designed to cope with the loads imposed by belt drives. Rolling element bearings shall be designed for an L-10 life exceeding 100 000 hours.

Belt drives shall incorporate lay shafts where necessary. Lay shafts shall be supported by bearings mounted in bearing housings which are adequately sealed and fitted with grease nipples. Bearing units incorporating open, shielded bearings are not acceptable.

Belt driven machinery shall be equipped with rolling element bearings; i.e. shall not be equipped with plain bearings.

## 17. Driven Gear Boxes

### 17.1 General

Driven gearboxes shall be supplied with environmental protection to IP 55 or higher.

The gearbox ratings shall be provided for an ambient temperature of 40 degrees Centigrade.

Gearboxes shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.

### 17.2 Service Factor

#### 17.2.1 Motor Driven Gearboxes

The service factor to be used for the design of gearboxes in uniform load duty shall be at least 1,25 for electric motor driven applications. A minimum service factor of 1,5 shall be used for moderate shock applications and a minimum service factor of 2 shall be used for heavy shock applications.

#### 17.2.2 Engine driven gearboxes

The service factor to be used for engine driven gearboxes shall not be less than 2.

### 17.3 Design Requirements

Gears shall be case hardened, profile ground and lapped, helical and spiral bevel gears.

The gearbox housing shall be of rigid cast construction preferably split in the horizontal plane.

Unless close coupled, each gearbox shall be mounted on machined sole plates fitted with jacking screws to assist with alignment.

Rolling element bearings shall be designed for an L-10 life in excess of 100 000 hours. A breather designed to prevent moisture from entering shall be fitted.

### 17.4 Lubrication

Oil-bath gearboxes shall have suitable oil level indicators or dipsticks which indicate the allowable



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levels. Inaccessible oil drain points shall be provided with extensions so that the oil can be easily drained. The drain line shall be of EN Grade 1.4401 (316) stainless steel and shall be fitted with a ball valve and square head plug.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

### 17.5 Oil Change

The Contractor shall drain and replace oil in all gearboxes during the Defects Notification Period.

### 17.6 Corrosion Protection

Gearbox external surfaces shall be provided with a coating suitable for the high corrosivity category (C4 of SANS 12944-2) and the dry film thickness shall not be less than 200 microns.

### 17.7 Manual Gearboxes

An over-torque limiting device shall be incorporated.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel. A breather designed to prevent moisture from entering shall be fitted.

## 18. Bearings

### 18.1 Bearing Choice

Bearing design shall suit the requirements of the equipment and the installation.

Greased lubricated bearings are acceptable for units with power ratings up to 100 kW but oil lubricated bearings are preferred for larger machines.

Units with power ratings above 1 000 kW shall be provided with plain bearings (oil film type). Plain bearings are also preferred for units with high speed shafts and for high temperature applications.

### 18.2 Operational Requirements

Bearing designs shall ensure safe shut down without damage following electrical supply failure.

Bearing designs for variable speed drive applications shall be suitable for the full expected speed range.

### 18.3 Rolling Element Bearings

For shaft sizes above 50 mm, the bearing shall be selected for an L-10 bearing life of at least 100 000 hours. This may be reduced if the equipment is expected to operate for less than 3 000 hours in a normal year.

Grease lubricated rolling element bearings shall be provided with relief against over greasing. Oil lubricated rolling element bearings shall be provided with an oil ring.

### 18.4 Plain Bearings

Plain bearings ("slide bearings", "oil-film bearings" or "sleeve bearings") which are oil lubricated shall have lubrication by oil ring, by rotating dish or by pumped feed or by a combination of these.

Lubrication shall be active during normal run down and during power failure and the design shall ensure that the bearing is not damaged.

Loss of pressure in pumped lubrication systems shall lead to shut down of the machinery.

Small diameter bushes shall preferably be self-lubricated sintered metal or of engineering polymer with suitable lubrication.

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## 18.5 Thermal Alarms

Thermal alarms on bearing systems shall be set in accordance with the equipment manufacturer's instructions.

Alarm settings done on Site shall be set after at least 24 hours of operation have occurred.

If high temperature protection is specified for a bearing, the Contractor shall note the equilibrium temperature reached after 30 minutes of normal operation and shall also note the ambient temperature. The high level trip temperature shall then be calculated as follows:

$$T_{\text{trip}} = T_{\text{equilibrium}} + (40^{\circ}\text{C} - T_{\text{ambient}}) + 10^{\circ}\text{C}.$$

(This assumes that the bearing is operating correctly.)

## 18.6 Belt Driven Equipment

Belt driven machinery and belt drive motors shall be equipped with rolling element bearings; i.e. shall not be equipped with plain bearings.

## 19. Lubrication

### 19.1 Type

Grease lubrication is generally acceptable where design parameters are not severe. Oil lubrication shall be provided where the design parameters are more severe.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall incorporate filters. Drain facilities shall always be provided.

### 19.2 Grease Lubrication

Where a grease point is not easily accessible, a grease line shall be piped to an easily accessible position for manual greasing. Each grease point shall be provided with its own grease point and pipework.

A distributor shall be provided where motorised lubrication is provided to more than one destination. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations. Only one distributor shall be used for each lubrication pump; i.e. distributors shall not be cascaded.

Pipework for grease distribution shall be of stainless steel.

### 19.3 Oil Lubrication

Where oil lubrication is provided, the Contractor is responsible for the initial oil fill and the first oil change, including flushing, draining and filling, after an initial run in period not exceeding 3 months

Oil level indicators shall be provided for visual checking. Drain valves, including EN Grade 1.4401

(316) fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1,5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

### 19.4 Submerged Bearing Housings

Submerged bearing housings shall be grease lubricated by motorised lubrication. The seals shall be arranged to avoid over-greasing of the bearing. These requirements apply to the bottom bearings of equipment such as Archimedes screw pumps but do not apply to equipment such as submersible

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pumps in which the bearing housing is contained within the pumpset housing.

## **20. Gauges**

### **20.1 Construction**

Gauges shall be of industrial construction. The case and bezel shall be of stainless steel unless this material is unsuitable for the application.

Pressure, vacuum or compound gauges shall comply with SANS 1062 and shall bear the Standards mark. Gauges shall be of Accuracy class 1.6 and Durability grade A.

The gauge reading shall indicate gauge pressure unless absolute pressure measurement has been called for.

Gauges shall have a scale diameter of not less than 100 mm.

Calibration shall be in mWC (metres Water Column). The units of measurement shall be clearly marked on the dial.

The scale shall be chosen so that the expected pressure is not less than half full scale reading but the full scale reading for a gauge on the discharge leg of a centrifugal pump shall be higher than the pump shut off head.

Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values.

Gauges shall be suitable for continuous operation and shall be glycerine filled on all pump applications and where fluctuations in pressure may cause damage.

Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating. On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of the gauge. The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

### **20.2 Installation**

Gauges shall not be mounted directly on equipment subject to vibration.

Gauges for pipework larger than DN 250 shall be remotely mounted, and isolating valves shall be provided at each end of the connecting pipework.

Gauges shall be mounted vertically and in such a position that they can be easily read from floor level.

Nozzles/sockets for gauges shall be provided in accordance with the clause "Steel Pipework; DN 150 and Larger".

Pressure gauges shall be fitted with an isolating and an air bleed valve. Valves shall be stainless steel ball valves with stainless steel operating levers.

Gauges for sludges and other liquids which contain solids shall have their nozzles on the side of the parent pipe. The configuration shall allow easy cleaning of the passageways.

Gauges used on wastewater, sludge, chemical, solids conveying or other applications where blockage or corrosion of the gauge is possible shall be fitted with a diaphragm type chemical seal, both being liquid filled. The portion of the seal in contact with the process liquid shall be of a suitable non-corroding material.

When used on steam lines a siphon shall be fitted between the steam line and the gauge which shall be filled with water before it is put into service.



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## 20.3 Electronic Instrumentation

Environmental protection of electronic instrumentation shall be as follows:

- 20.3.1. Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.
- 20.3.2. Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self-draining.
- 20.3.3. Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all around the instrument.
- 20.3.4. Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.
- 20.3.5. Instruments shall have permanently affixed nameplates. Calibration certificates shall be included in the Manual.

## 21. Guard Rails

### 21.1 General

Legislated requirements call for guard railing to be provided in positions where the vertical change in level is 1 000 mm or greater.

Guard railing shall comply with SANS 10104 and shall be designed for access for maintenance purposes.

### 21.2 Operational Requirements

Guard railing shall be designed to resist, without any damage and without excessive deflection, the loadings in Category E in Table 7 in Clause 9.4 of SANS 10160 2:2011, Edition 1.1, namely:

- a) a force of 1 000 Newtons in any direction (concentrated over a length of 100 mm).
- b) a distributed horizontal force of 1 000 Newtons per metre applied along the top rail.

### 21.3 Design Requirements

Guard railing shall be designed to resist the loadings set out in SANS 10160.

Hand and knee rails shall have an outside diameter of not less than 33 mm and a wall thickness of not less than 2,5 mm and a maximum span of 1 500 mm (greater spans will be acceptable if heavier tube dimensions are used).

Tubular stanchions shall have a wall thickness of at least 3,0 mm.

On platforms, walkways, landings or around dangerous areas the vertical height, measured from the top of the hand rail to the floor or surface, shall be at least 1 000 mm.

On stairways and fixed ladders, the rails shall be parallel to the strings, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

No opening between rails shall allow the passage of a ball of diameter 600 mm.

Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded or sheared off.



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Welded guard rail installations are preferred. Installations which incorporate bolted sections shall be secure and tight under loading. "Pop" rivetted installations will not be acceptable. Joints shall be smoothly finished, without shoulders.

Railings shall be ended off with positively fixed closure bends. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically designed for such a position shall be employed. No sharp ends will be permitted.

Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction.

Stanchions which are hollow shall be self-draining.

Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm X 8 mm. Two fasteners of minimum size M16, shall be used to secure each foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under stanchion feet to prevent the formation of crevices.

Stanchion feet which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 mm X 10 mm. In instances where the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated on at least two surfaces. Four fasteners of minimum size M16, shall be used to anchor the foot. Non-shrink, cementitious grout shall be applied under the foot prior to final tightening of nuts.

Kickplates shall be provided. These shall extend to 150 mm above the walkway level.

#### **21.4 Additional Design Requirements for Guard Railing in Public Places**

The requirements for guard railing at equipment installations shall also apply for guard railing for public places. The following specific requirements shall also be complied with:

26.2.23 The structural design shall be done in accordance with the requirements of SANS 10104.

26.2.24 No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

#### **21.5 Carbon Steel Guard Rails**

Fabrication and welding shall comply with the clauses "Fabrication of Carbon Steel and Stainless Steel" and "Welding".

The guard rails shall be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided.

If the guard rails are welded or cut after hot-dip galvanising, they shall be returned to the galvaniser for re-galvanising.

#### **21.6 Stainless Steel and 3CR12 Guard Rails**

Fabrication and welding shall comply with the clauses "Fabrication of Carbon Steel and Stainless Steel" and "Welding".

#### **21.7 Fasteners**

All anchor fasteners, including nuts and washers shall be of EN Grade 1.4401 (316) stainless steel. Fastener diameter shall not be less than M12.

### **22. Grid Flooring**

The depth of bearer bars in metal grid flooring shall not be less than 30 mm with a bearer bar pitch of



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not greater than 40 mm.

The bearer bars shall be across the shorter span.

Panels shall be set level and fixed to angle frames to prevent rocking.

Cut-outs in grid flooring for pipes, valve spindles, etc. are to be fully banded. The edges of removable grid access covers must also be fully banded. Corrosion protection shall only be done after welding of banding has been completed.

Unless another material such as stainless steel is specified, grid flooring and frames shall be of carbon steel, hot-dip galvanized after fabrication. If hot-dip galvanising is not suitable, a glass flake resin, such as Power Blast's Vitaglass or equivalent which is applied by dipping the flooring in catalysed resin, is acceptable. Painted coatings are not acceptable as corrosion protection.

Where grid flooring rests on painted surfaces, strips of rubber insertion material shall be secured under the grid to protect the paint.

The fixing clip set (saddle clamp and locking plate) shall be of hot-dip galvanised steel or stainless steel. Fasteners shall be of EN Grade 1.4401 (316), or better.

GRP grid flooring is not acceptable.

## **23. Fasteners**

### **23.1 Standards**

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.

### **23.2 Loading / Stress**

Fasteners shall be loaded in accordance with their design and shall not be loaded as columns and/or in bending. In particular, anchor fasteners shall only be loaded in tension and sideways forces shall be transferred to the concrete structure in which they are anchored.

### **23.3 Materials**

M12 fasteners and smaller shall be of EN Grade 1.4401 (316) or better.

Fasteners in corrosive areas shall be of EN Grade 1.4401 (316) or better. Corrosive areas shall be taken to include any moist or wet area such as in and above settling tanks, in or in the vicinity of open channels, where a continuous spray can be expected and all areas in the vicinity of a wastewater treatment works or wastewater sump.

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

Plated fasteners are not acceptable.

### **23.4 High Tensile Bolts**

Where high tensile bolts are required by the design, they shall be hot-dip galvanized and painted. The bolt holes and crevices shall be filled and sealed prior to painting.

### **23.5 Anchor Fasteners**

Anchor fasteners shall be of EN Grade 1.4401 (316), or better.

Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Other anchors may be of the expanding type or chemical anchor type.



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Where hook bolts are used, these shall be supplied and grouted by the Contractor into pockets which will be provided in the concrete structure in accordance with the information to be supplied by the Contractor. The grouting products shall be used strictly in accordance with the manufacturer's instructions.

Where machinery is anchored by studs or bolts which extend through the supporting structure and is therefore fastened down with the use of nuts from both sides, the studs or bolts, together with associated washers and brackets, shall also be of EN Grade 1.4401 (316), or better.

Anchors shall be tensioned when their nuts are tightened, i.e. it is not acceptable to use a second nut below the baseplate to position it; and the holding down force shall be loaded into the concrete structure rather than the baseplate being held between two nuts.

Submerged anchors shall be secured with chemical anchor designed for submersion.

### 23.6 Material Compatibility

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. EN Grade 1.4401 (316) bolts must be used to fasten together EN Grade 1.4401 stainless steel flanges and fabrications.

### 23.7 Washers

Flat washers shall be provided under nuts and setscrew heads.

Flat washers shall be provided under bolt heads on painted surfaces.

Flat washers shall be provided under bolt heads where the bolt is positioned in a slot.

Spring washers shall be used on fasteners subject to vibration (other approved locking arrangements will also be acceptable on proprietary equipment).

Anchor bolts for machinery shall each be provided with a flat washer and a spring washer (other locking arrangements are not acceptable).

Washers shall be of the same material as the fasteners.

Flat washers exhibiting visual deformation shall be replaced by thicker washers.

### 23.8 Anti-seize Compound

Before assembly, stainless steel threads shall be treated with a nickel-based, anti-seize/corrosion protection compound such as Chesterton 725: Nickel Anti-Seize Compound, or equivalent. Copper based compounds are not acceptable.

A small amount of the compound shall be applied along the full length of the exposed thread before fastening. Excessive compound visible on the thread after the nut has been applied is unacceptable and indicates that the compound has not been used correctly.

### 23.9 Thread Projection

Bolt threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed. Longer projections will only be allowed if the Contractor can show that bolts of a more suitable length are not manufactured.

### 23.10 Corrosion Protection

After installation, the exposed surfaces of fasteners not of stainless steel shall be coated as for the items being fastened.

If the use of Allen head or similar fasteners has been approved by the Engineer, the recessed heads shall be filled with a suitable non-hardening sealing compound.



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## 24. Machine Vibration

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

Reciprocating machines shall be designed and installed so that the machine vibrations are isolated from the floor structure. Vibration isolation mountings which will eliminate not less than 90 % of the vibrations transmitted by the equipment shall be provided between the base frame and the concrete plinth. When mounted on the vibration isolators, distortion of the base frame shall be negligible in comparison with the permissible and acceptable misalignment of the equipment mounted thereon.

Shafts shall be designed so that the critical speed is outside the operating speed range.

## 25. Noise Control

### 25.1 General

Noise emitted by equipment shall be kept to a minimum and shall not exceed the noise levels specified in these documents.

### 25.2 Noise Levels

The sound power of any equipment shall not exceed 89 dB(A) (referred to  $10^{-12}$  Watts) unless specifically approved by the Engineer. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment, e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc.; the Contractor shall inform the Engineer so that appropriate steps can be taken to counteract the effects of noise.

### 25.3 Acoustic Treatment

Standard acoustic enclosures shall be provided where called for.

Acoustic treatment of high noise sources shall be provided where this can be done without greatly interfering with operation or maintenance.

If acoustic lagging of pipework or ducting is specified, this shall consist of pre-formed rockwool encapsulated in stainless steel sheet metal. Alternatively, a 100 mm thick layer of rockwool having a density of  $60 \text{ kg/m}^3$ , suitably fixed in place and reinforced to prevent collapse, and covered with 25 mm thick asbestos free plaster having a density of  $1\,000 \text{ kg/m}^3$  (I.P. Insultex AF720, or equivalent). The outer surface shall be finished off with scrim cloth before being painted.

It is not normally necessary to lag flow meters and cast iron valves on acoustically lagged pipelines.

Components which can move, such as those associated with expansion bellows or mechanical couplings, shall be enclosed by an effective acoustic enclosure designed to prevent sound transmission but able to cope with movement without damage.

### 25.4 Measurement

Noise levels will be verified by taking impulse weighted  $L_{eq}$  readings in dBA over ten minutes at the specified positions. Readings so achieved shall not exceed the specified level by more than 2 dBA. Should the noise exceed the specified level, or should the level be in dispute, the Contractor will be responsible for obtaining certified sound pressure levels across the full octave band mid-frequency range in order to establish the precise A weighted level.

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## 26. Thermal Lagging

Thermal insulation shall only be carried out after successful pressure testing of the equipment.

The efficiency of the insulation system shall exceed 90 % and the insulation cold face temperature shall not exceed 40 °C.

Pipe insulation shall consist of pre formed insulation material having a thermal conductivity of approximately 0,040 W/m °K at 60 °C. The insulation material shall not have any corrosive effect on the pipework and, in particular, it must be noted that fibreglass may not be used on stainless steel.

Inside buildings, or in other protected areas, pipe insulation shall be supplied with a canvas covering having a 50 mm lap at one end and along the longitudinal seam. The laps shall be sealed using a suitable lagging adhesive. On bends the insulation material shall be neatly mitred and covered with canvas. At all flanges the insulation shall be closed off. Flanges, couplings, tees and valves shall be insulated using a removable canvas blanket or jacket fastened in place with brass hooks and eyes.

All insulation shall be coated with a suitable sealer and then painted in accordance with the colour code. The manufacturer shall advise regarding the paint types and system to be used.

Outside buildings or in other exposed areas pipe insulation shall be fixed in position using three bands per section or a suitable adhesive and then clad with aluminium. All longitudinal and circumferential joints shall incorporate a 50 mm lap with each edge grooved. The longitudinal joints shall be positioned in the "twenty past" position with the lap and groove downwards. All ends next to couplings or flanges shall be closed off and sealed before fitting muff type insulation and cladding over the couplings and flanges. All bends, tees and other fittings shall also be insulated and clad, but valves need not be insulated. All joints shall be primed and sealed using a silicone or other appropriate sealer and the contractor shall generally ensure that the lagging is weatherproof with particular attention being paid to all joints and pipework support or anchor points.

With large exposed items such as vessels mounted outside, a suitable system incorporating a 20 mm thick, smooth layer of weatherproof, reinforced plaster covered with a scrim cloth and overcoated with at least two coats of fibre reinforced resin sealer shall be acceptable.

## 27. Spares

Spares which are specified as part of the Works shall be packed individually in wooden boxes with the lids unattached. Each box shall be labelled with the Contract number, manufacturer, contents, relevant part/model numbers and the supplier's address. The boxes shall be brought to Site and the lids shall be secured to the boxes immediately after the Engineer has approved the spares and the packaging.

## 28. Signage

### 28.1 General

All signs as specified below shall be installed prior to commissioning.

### 28.2 Operating Instructions

Operating instructions shall be framed and shall be attached to the wall in the control room using brass screws. The frame shall be of wood or aluminium with a glass front and hardboard backing. They shall include the following:

- 28.2.1 Start up, Shut down and Operating instructions shall be comprehensive and shall indicate actions to be taken in the case of all alarm conditions. These shall be written from the point of view of the plant operator.



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28.2.2 A layout drawing of the equipment installation.

28.2.3 A process flow diagram.

28.2.4 A P&ID.

### 28.3 Safety

Safety signs shall be suitably framed or encapsulated. Symbolic signs shall comply with SANS 1186. The wording of the signs shall be approved by the Engineer prior to final printing. They shall be provided by the Contractor in appropriate places on the walls of the plant room and shall include the following:

28.3.1 All statutory and special safety warning instructions.

28.3.2 Course of action during/after electrical shock.

28.3.3 Any operating restrictions for equipment.

28.3.4 Operating instructions in cases of plant trip and electrical supply failure.

28.3.5 Spares list.

## SPECIFICATION: MECH 0002: OPERATING AND MAINTENANCE MANUAL

### 1. Introduction

Mech 0002 specifies the requirements for the Operating and Maintenance Manual to be provided by the Contractor.

### 2. Submission of Manual

The Contractor shall submit the Manual to the Engineer for acceptance. If the Manual does not comply with this specification and/or is incorrect, the Contractor shall correct it and re-submit it for acceptance until the Engineer accepts it. At each submission, the Contractor shall provide a duplicate copy for the Employer.

Six copies of the final version of the Manual, as accepted by the Engineer, shall be provided prior to the issue of the Taking Over Certificate by the Engineer and the start of the Defects Notification Period.

### 3. General Requirements

The Manual shall be for the complete Works.

The Manual shall be in English and shall be practically and neatly presented.

One Manual shall contain original documents and this set shall be marked "Original". The other 5 Manuals shall contain all the information in the original and shall be marked "Copy 2" to "Copy 6".

Binders shall have hard, plastic protected covers utilising four-ring, spring-clip holders. Each binder shall not be more than two-thirds full. A title label shall be affixed to the spine of each binder. This shall indicate the Employer, the Contract number, title, Contractor's name, Site/Plant name and volume number.

Sections and sub-sections shall be titled, uniquely numbered and provided with separator sheets. Manufacturer's printed matter shall be marked to identify the model provided.

Drawings shall be to a scale which makes details clear. Large drawings shall be held in plastic envelopes in the Manual. A4 and A3 drawings may be bound as normal pages. Drawings shall also be provided on electronic data storage in AutoCAD, or equivalent, format.



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Cross-referencing within the Manual is acceptable if this will avoid duplication.  
Three copies of the complete Manual shall be provided in pdf format, on flash drives.

#### 4. Format and Contents

The Manual shall comply with the following format:

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| NO       | HEADING                        | CONTENT                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | <b>General</b>                 |                                                                                                                                                                                                                                                                                                                                                                                          |
| 1.1      | Contents List                  | Contents list for complete Manual.                                                                                                                                                                                                                                                                                                                                                       |
| 1.2      | Description of the Works       | Description of the equipment installation with layout drawings and process flow diagrams.<br>Process description and performance parameters for the Works.                                                                                                                                                                                                                               |
| 1.3      | Equipment List                 | Single list of the make, model, operating range and hazardous zoning of every item of mechanical, electrical, instrumentation and control equipment.                                                                                                                                                                                                                                     |
| 1.4      | Drawing List                   | List of the Contractor's drawings.                                                                                                                                                                                                                                                                                                                                                       |
| <b>2</b> | <b>Operation</b>               |                                                                                                                                                                                                                                                                                                                                                                                          |
| 2.1      | Training Manual                | Brief description of the complete operating system containing:<br>Start-up, adjustment, operating and shut-down procedures for manual and automatic operation - Emergency operating procedures - Process verification - Settings, setpoints, protection, alarms and trips.<br>A paper copy of this document shall be provided to each trainee.                                           |
| 2.2      | Commissioning                  | Trainee attendance registers & Commissioning results.                                                                                                                                                                                                                                                                                                                                    |
| <b>3</b> | <b>Maintenance Schedule</b>    |                                                                                                                                                                                                                                                                                                                                                                                          |
|          |                                | Schedule of routine maintenance for all <b>mechanical, electrical, instrumentation and control</b> equipment, broken down into daily, weekly, monthly and annual periods.<br>The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual.<br>The schedule shall include <b>all</b> lubrication periods, lubricants and capacities. |
| <b>4</b> | <b>Mechanical Equipment</b>    |                                                                                                                                                                                                                                                                                                                                                                                          |
| 4.1      | Equipment item 1 (e.g. pumps)  | <ul style="list-style-type: none"> <li>- The make, model, serial number, description, size, design range, performance data, motor and drive details and supplier's details of the item.</li> <li>- Dimensioned drawing.</li> <li>- A photograph of the nameplate.</li> <li>- Manufacturer's operating and maintenance manual.</li> <li>- Operating curves, test results, etc.</li> </ul> |
| 4.2      | Equipment item 2 (e.g. mixers) | ditto                                                                                                                                                                                                                                                                                                                                                                                    |



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|          |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.3      | etc.                                        | ditto                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>5</b> | <b>Electrical Equipment</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5.1      | Equipment item 1 (e.g. transformer)         | As for 4.1 above; <i>PLUS</i> :<br>Control and electrical details, including logic sequence, circuit diagrams and software, as applicable - <b>Electrical reticulation drawings</b> - <b>Equipment overall dimensions</b> - <b>Wiring diagrams</b> - <b>Switchboard layout drawings</b> - <b>SLDs</b> .                                                                                                        |
| 5.2      | Equip. item 2 (e.g. VFCs)                   | ditto                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5.3      | etc.                                        | ditto                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>6</b> | <b>Instrumentation Equipment</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6.1      | Instrumentation Equip. Item 1 (e.g. Magflo) | As for 4.1 above; <i>PLUS</i> :<br>Circuit diagrams of instrumentation systems and of individual instruments - Installation arrangement - Normal operating range - Calibration procedures.                                                                                                                                                                                                                     |
| 6.2      | Equip. Item 2 (e.g. level)                  | ditto                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>7</b> | <b>Control</b>                              |                                                                                                                                                                                                                                                                                                                                                                                                                |
| 7.1      | Identifying Information                     | Make and model of PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.                                                                                                                                                                                                                                                                                                                   |
| 7.2      | I/O List                                    | Cross-referenced listing of all I/Os used.                                                                                                                                                                                                                                                                                                                                                                     |
| 7.3      | SCADA                                       | Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.                                                                                                                                                                                                                                |
| 7.4      | Program                                     | An annotated program listing. CDs containing all software. Loop and logic diagrams for each PLC. System control diagram and logic sequence chart.                                                                                                                                                                                                                                                              |
| 7.5      | Documents                                   | Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.                                                                                                                                                                                                                                                                                                                                          |
| <b>8</b> | <b>Documents</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8.1      | Drawings                                    | As-built drawings, including GAs, MFDs, P&IDs, electrical panel construction drawings, etc. These shall also be provided electronically.                                                                                                                                                                                                                                                                       |
| 8.2      | Cable Schedule                              | Cable schedule for power, data, control and instrumentation cables. This shall include the cable construction, conductor material, insulation, protection, voltage rating, start and finish points, route length, duty, load, voltage drop, core area, no. of cores, no. of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification |



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|     |       |                                                                                                                                                                                                                               |
|-----|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |       | and date of manufacture.                                                                                                                                                                                                      |
| 8.3 | Other | Protection relay settings and test certificates - List of spares provided -<br>Certificate of electrical compliance - Corrosion protection systems used -<br>Coating supplier's data sheets and coating<br>repair procedures. |

## **SPECIFICATION: MECH 1001: PERMANENT LADDERS**

### **1. Introduction**

Mech 1001 specifies the standard requirements for permanent metal ladders to be provided by the Contractor.

Permanent ladders shall comply with the requirements of the OHS Act.

### **2. Scope of Works**

See project specification.

The installation shall be configured as shown on applicable drawings.

### **3. Normative References**

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- Amendments. Amendments, Additions and Detailed Requirements (Mech 1001).
- Mech 0001: General Mechanical Requirements.
- Mech 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

### **4. Design and Construction**

#### **4.1 Ladder**

The width between strings shall be between 400 mm and 500 mm.

The rise height shall be between 250 mm and 300 mm. All rises in a flight shall be uniform.

A minimum clear space of 230 mm shall be provided behind the rungs along the full height of the ladder.

The distance between anchoring supports shall not exceed 2 000 mm.

Strings, rungs and supports shall be of solid structural sections (e.g. flat bar, round bar, square bar, angles, etc.). Hollow sections are not acceptable for any part of the ladder.

Strings shall be formed from 65 mm X 10 mm flat bar; or larger section.

Rungs for stainless steel ladders shall be one of the following (in order of preference):

- 20 mm stainless steel rebar



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Witness 1



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- 20 mm stainless steel round bar with knurled (or otherwise roughened) surface.
- 20 mm stainless steel surface roughened square bar (with sides horizontal and vertical; i.e. not diamond configuration).

Rungs for hot-dip galvanised carbon steel ladders shall be one of the following (in order of preference):

- mm carbon steel rebar,
- mm carbon steel round bar,
- mm carbon steel square bar (with sides horizontal and vertical; i.e. not diamond configuration).

Rungs shall be welded to strings. It is not required that rungs penetrate strings.

The top rung shall be level with the upper landing. Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap behind the ladder. These additional rungs shall have a spacing of approximately 75 mm.

#### 4.2 Top Structure

The strings shall extend to at least 1 100 mm above the upper landing and shall complement any guard rails at this level.

The top structure shall be rigid and shall be designed so that the climber's hand slides along the gripped members without snagging.

Access to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

Ladder/guard rail connections between stainless steel and hot-dip galvanised steel shall be bolted.

Footings onto concrete shall have minimum dimensions of 150 mm X 150 mm X 10 mm plate thickness. If the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated securely on at least two surfaces. Four fasteners of minimum size M16, shall be used to anchor the foot.

Footings onto steel structures shall have minimum dimensions of 150 mm X 60 mm X 8 mm plate thickness. Two fasteners of minimum size M16, shall be used to secure each foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under the feet to completely seal the crevices between the two metallic surfaces.

#### 4.3 Cage

If the ladder exceeds 5 000 mm in length, it shall be provided with a cage which extends from 2 300 mm above ground level to at least 1 100 mm above the upper landing served by the ladder. The cage shall comprise no fewer than five vertical elements in addition to the strings. The vertical distance between horizontal hoops shall not be greater than 1 000 mm.

The safety cage "shall afford firm support along its whole length for the back of the person climbing the ladder, and for which purpose no part of the cage shall be more than 700 mm away from the level of the rungs." (as per OHS General Safety Regulations). The preferred dimension is 650 mm.

Hoops and verticals shall be formed from 50 mm X 8 mm flat bar, or larger.

#### 4.4 Platforms

Platforms shall be provided in accordance with the requirements of the OHS Act.

Ladders with a height greater than 10 metres shall be provided with intermediate landings which are spaced apart by not more than 8 metres.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Platforms and landings shall be 850 mm X 850 mm or larger. They shall be provided with guard rails and kick plates complying with Mech 0001.

#### 4.5 Materials and Corrosion Protection

Ladders, cages, etc. shall either be of stainless steel or shall be of carbon steel as specified elsewhere.

Carbon steel ladders shall be hot-dip galvanised after all fabrication has been completed. The unit shall be blasted and re-galvanised if it is welded, drilled or ground or the zinc layer is damaged by any fabrication activity.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Corrosion Protection shall comply with Mech 0003.

#### 4.6 Fabrication

Fabrication and welding shall comply with Mech 0001.

#### 4.7 Fasteners

Anchor bolts in concrete and brickwork shall be of EN Grade 1.4401 (316), or better, and shall be no smaller than M16. Other bolts may be of hot-dip galvanised steel unless specified otherwise.

Fasteners shall comply with the clause "Fasteners" in Mech 0001.

#### 4.8 Installation

Installation work shall comply with Mech 0001.

Access for installation of permanent ladders is normally hazardous and, as for all of the Works, the Contractor shall ensure that all such work is executed in accordance with the requirements of the OHS Act and other applicable national regulations.

#### 4.9 Civils and Building Work

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

#### 4.10 Inspections

The Contractor shall make arrangements for the Engineer to inspect the fabricated ladders for compliance prior to corrosion protection and prior to payment being made.

The Contractor shall arrange for the Engineer to inspect the completed installation before commissioning.



Contractor



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Employer



Witness 1



Witness 2

## SPECIFICATION: MECH 1003: LIFTING EQUIP

### 1. Preamble

Part A of Mech 1003 specifies general requirements for all lifting equipment to be provided by the Contractor.

Part B of Mech 1003 specifies additional requirements for the following types of lifting equipment:

- Steel gantries.
- Travelling cranes.
- Hoists.
- Manual hoist trolleys.
- Crawl beams.
- Davits.
- Hand cranked winches.

## PART A: GENERAL REQUIREMENTS FOR ALL LIFTING EQUIPMENT

### 2. Scope of Works

The project specification defines the Contractor's responsibility for providing lifting equipment such as steel gantries, travelling cranes, hoists, hoist trolleys, crawl beams, davits and/or hand cranked winches.

The installation shall be configured as shown on applicable drawings.

### 3. Normative References

The following form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Mech 1003).
- b) Mech 0001: General Mechanical Requirements.
- c) Mech 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- d) Mech 1001: Permanent Ladders.
- e) SANS 50025: Hot Rolled Products of Structural Steels.
- f) SANS 2063: Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.
- g) SANS 4310: Cranes – Test Codes and Procedures.
- h) BS 466: Specification for Power Driven Overhead Travelling Cranes, Semi-Goliath and Goliath Cranes for General Use.
- i) BS 2573: Rules for the Design of Cranes. Specification for Classification, Stress Calculations and Design Criteria for Structures.
- j) BS EN 1011: Welding. Recommendations for welding of metallic materials.
- k) BS 4872: Specification for approval testing of welders when welding procedure approval is not required.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national



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Witness 2

and/or international standard.

#### 4. Equipment Eligibility

Lifting equipment components shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available.

#### 5. Performance Requirements

The lifting equipment shall safely lift any load between zero and the test load and shall be capable of traversing the full operating footprint whilst holding these loads. All three travel movements shall be free of snatching, shuddering and crabbing over their full travel distances.

#### 6. Technical Requirements

##### 6.1 Technical Standards

In accordance with 18. (1) (a) of the Driven Machinery Regulations, lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard for lifting equipment.

The standard used shall be noted on all Contractor's drawings submitted for review.

##### 6.2 Manufacturer's Identification Plate

In accordance with 18. (1) (c) of the Driven Machinery Regulations of the Occupational Health and Safety Act, the manufacturer's identification plate shall be fixed to the equipment and shall display the manufacturer, the design standard, the serial number and the country of origin

##### 6.3 General

Lifting equipment shall be in accordance with the Occupational Health and Safety Act and Regulations and, in particular, with Regulation 18 of the Driven Machinery Regulations.

The guidelines given in the Southern African Steel Construction Handbook may be used where applicable and where these do not conflict with the technical standard.

The safe working load of the lifting equipment ("SWL") shall exceed the heaviest load to be lifted by at least 30 %. The SWL shall be permanently marked on all components.

The lifting equipment will be used intermittently.

The lifting equipment, when erected and installed, shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

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Contractor

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Employer

Witness 1

Witness 2

#### 6.4 Test Load

The complete installation shall be designed to handle the test load.

#### 6.5 Fabrication

Fabrication and welding shall comply with Mech 0001.

#### 6.6 Structural Components

Hollow sections are not acceptable as structural members unless the section is fully closed by welding.

#### 6.7 Fasteners and Anchoring

Fasteners shall comply with Mech 0001.

Steel foot-plates for securing steel structures to concrete shall have a minimum of four anchor bolts.

Anchor fasteners shall have a diameter of not less than M16 and shall be of EN Grade 1.4401 (316), or better. Other fasteners, including high tensile fasteners, shall be of stainless steel or of hot-dip galvanised steel. Fasteners which form standard parts of proprietary equipment and do not comply with these material requirements will require an additional anti-corrosion coating to suit the environment.

Chemical anchor shall not be used where the fastener is in tension, i.e. where the load is hung on the anchor fastener. Such anchors shall preferably be through-bolted. Mechanical anchors will also be acceptable but application of the test load on the completed installation shall not cause the loading on the anchor to exceed 45 % of the anchor manufacturer's recommended loading at any position of the load.

#### 6.8 Corrosion Protection

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Mech 0003.

#### 6.9 Motors

Motors shall comply with Mech 0001.

Motors shall have ingress protection to at least IP 55 and shall comply with the electrical specifications.

Electronic variable speed drives are acceptable for both hoisting and for travel, but the control system shall prevent the motor from being overloaded under all load conditions.

#### 6.10 Factors of Safety

The factors of safety for cables, chains, webbing, fibre ropes etc. shall comply with the requirements of the Driven Machinery Regulations of the Occupational Health and Safety Act.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



### 6.11 Wheels

All wheels shall be provided with a fail to safe device ("drop stop") in case of wheel or axle breakage.

### 6.12 Operating Chain

The operating chains of manually operated hoists shall fall to one metre above floor level.

### 6.13 Civils and Building

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and accepted by the Engineer.

### 6.14 Electrical Equipment

Electrical Equipment shall comply with the electrical specifications.

### 6.15 Inspections

#### 6.15.1 Workshop / Factory

The Contractor shall arrange for the Engineer to inspect fabrications at the following stages:

- a) after fabrication. During this inspection and in the presence of the Engineer, the Contractor shall conduct dye penetrant testing of all welds on structural members. This includes welding of peripheral items onto structural members (such as brackets for attachment of platform supports).
- b) after blasting.
- c) after the final coat (but before the items are transported from the coatings yard).

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the equipment for acceptance prior to dispatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to dispatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer, or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. Prior to the equipment being dispatched from the manufacturer's works, this report shall be submitted to the Engineer and shall confirm compliance of the equipment with the specifications.

#### 6.15.2 Site

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.



Contractor



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Witness 2



Employer



Witness 1



Witness 2

### 6.15.3 Inspection During Defects Notification Period

The Contractor shall check the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

### 6.16 Testing, Certification and Use of Equipment

#### 6.16.1 Testing

Lifting equipment and installations shall be tested after installation. The Contractor shall comply with all aspects of SANS 4310. In accordance with ISO 4310, the test load shall be 1,25 times the SWL, and this load shall be traversed over the full range of operation in order to test the structure in every position.

The Contractor shall conduct the testing procedures, shall provide the test load and shall arrange for the Engineer to witness this test.

The test certificates shall be submitted to the Engineer.

#### 6.16.2 Contractor's Use of Lifting Equipment

The Contractor may use the lifting equipment for the installation of other parts of the Works if testing and certification for the complete lifting installation has been successfully completed.

#### 6.16.3 Employer's Use of Lifting Equipment

Upon commissioning/taking over/start of the Defects Notification Period, the lifting equipment shall be available.

The Contractor shall provide the following:

- the required inspections [18.(6) of the Driven Machinery Regulations] within the previous three months, and;
- the testing required by [18.(5) of the Driven Machinery Regulations] within the previous six months,

so that the equipment can immediately be used by the Employer fitly and legally. The Contractor shall provide confirmatory documentation at commissioning.

## PART B: ADDITIONAL REQUIREMENTS FOR PARTICULAR TYPES OF LIFTING EQUIPMENT

### 7. Steel Gantries

#### 7.1 Preamble

A "gantry" is the structure which supports the lifting equipment.

Steel gantries shall comply with the General Requirements for All Lifting Equipment and with the additional requirements of this sub-clause.

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Contractor

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Employer

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Witness 2

## 7.2 General

The same technical standard used for design of the crane or crawl beam shall be used for the steel gantry design.

Columns shall be cross-braced and/or “triangulated” in more than one plane, i.e. columns shall not be cantilevered in any vertical plane.

## 7.3 Corrosion Protection

Gantry steelwork shall be hot-dip galvanised.

If it is not feasible to hot dip galvanise the gantry steelwork, it shall be protected by a duplex system consisting of hot-metal zinc-spray, sealant and coating in accordance with the requirements for crane beams in Mech 1003.

## 8. Travelling Cranes

### 8.1 Requirements for all Travelling Cranes

#### 8.1.1 Preamble

Travelling cranes shall comply with the General Requirements for All Lifting Equipment and with the additional requirements of this clause.

“Travelling Cranes” refers to:

- Overhead travelling cranes.
- Goliath cranes
- Semi-goliath cranes.

#### 8.1.2 General

The SWL shall be greater than the weight of the heaviest item of equipment to be lifted, as specified elsewhere in Mech 1003.

#### 8.1.3 Certificate

The Contractor shall submit a certificate from the crane manufacturer which certifies that the crane has been manufactured in accordance with the requirements of the Driven Machinery Regulations of the Occupational Health and Safety Act. It shall also refer to the technical standard used and shall state the SWL and the test load.

This certificate shall be provided to the Engineer prior to delivery of the crane to Site.

#### 8.1.4 Configuration

The long travel, cross travel and hook travel shall be electrically powered. The lowest hook level shall be floor level of the area to be serviced.

Cranes shall be designed with suitable dimensions, wheel spacings and gusset plates or diagonal bracing to prevent slewing. The wheel base of end carriages shall be at least one seventh of the crane span.



Contractor



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Employer



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Witness 2

End stops with rubber buffers shall be fitted to prevent the hoist from moving off the travelling beam. Stops and buffers are also required to limit the long travel on the rails.

#### **8.1.5 Construction**

Construction of overhead travelling cranes, goliath cranes and semi-goliath cranes shall be in accordance with BS 466 and BS 2573 (or BS EN 13 001), as applicable. Suitable equivalent standards are acceptable. All welding of steelwork shall be carried out in accordance with BS EN 1011 by competent artisans meeting the requirements of BS 4872. Suitable equivalent standards are acceptable.

All materials shall be new and unused and suited to the application. Structural steelwork shall comply with the requirements of SANS 50025 for grade S 355 JR or for grade S 355 JO.

#### **8.1.6 Operation**

All three directions of travel shall be driven by squirrel cage induction motor preferably fed by electronic variable speed drives. Starting and stopping shall be smooth. Inching capability shall be provided for all three directions of travel. Both long and cross travel shall revert to low speed prior to contact with the end stops.

#### **8.1.7 Rails**

The crane rails shall be standard rail sections to DIN 536, or equivalent. Square section steel bar is not acceptable.

Rail lengths shall be joined using fish-plates, with at least four fasteners, to provide the crane wheels with a smooth passage across the join.

Rails shall be secured with rail fastenings at a spacing not greater than one metre. Every rail length shall be supported at both its ends.

#### **8.1.8 Crane Hoists**

Crane hoists are specified elsewhere in Mech 1003.

#### **8.1.9 Machine Components**

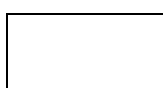
Gear wheels and other machine components shall be fully enclosed against dust. If not installed internally, they shall have ingress protection to at least IP 55.

Bearings shall be mounted in sealed, cast iron bearing housings and shall be provided with grease nipples.

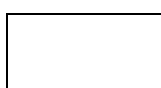
#### **8.1.10 Electric Cabling**

Cables shall preferably be of the insulated, festooned type and shall be suitable for the applicable hazardous zone classification.

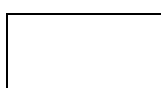
Winding drum cables shall be provided with protection for the full length of the cable lay so accidental



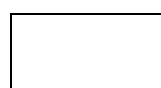
Contractor



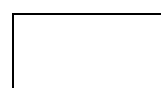
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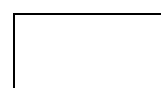
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Employer



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Witness 2

damage is prevented, e.g. it shall not be possible to walk on the cable.

Travelling brush contacts are not normally acceptable and are prohibited on wastewater treatment works and in other corrosive and hazardous environments.

#### **8.1.11 Corrosion Protection**

The Contractor shall arrange for the fabrication of the crane to be inspected by the Engineer for acceptance at the fabricator's premises prior to corrosion protection.

Smaller items, such as cable brackets and protective covers, shall be hot-dip galvanized. Crane rails shall be hot-dip galvanized.

The crane beam and end carriages shall be hot-metal zinc-sprayed and sealed and coated. The thermal spray metal coating shall be in accordance with SANS 2063. The minimum zinc coating thickness shall be 150 µm. The sealant shall consist of the application of a two-part epoxy primer to a dry film thickness of 40 µm; (Carboline Rustbond Penetrating Sealer, Intergard 269, thinned Carboguard 545, or equivalent. The coating shall consist of at least two coats of a two-part polyurethane enamel to a minimum combined dry film thickness of 70 µm.

Corrosion protection shall comply with Mech 0003.

#### **8.1.12 Installation**

The crane rails shall be straight, over their entire length, to within the permissible deviations in BS 466.

Rail anchor fasteners shall be M16 or larger and shall be of EN Grade 1.4401 (316) or better.

Crane rails which are mounted directly on concrete beams shall be grouted along the full length of the rails. Grouting shall be done using a non-shrink, cementitious grout, ABE Duragrout 1000 or equivalent, to the acceptance of the Engineer and in accordance with the manufacturer's instructions. A suitable gap between the rails and the beam shall be provided for application of the grout. The grout shall be applied to a clean, scabbled concrete surface strictly in accordance with the manufacturer's instructions. The grout shall be neatly finished with a 45° chamfer. The Engineer shall be notified prior to application of the grout.

Shims shall be fully grouted in to provide corrosion protection.

#### **8.1.13 Access for Installation**

The Contractor shall determine a suitable method of installation and shall timeously submit an installation method statement to the Engineer for review.

### **8.2 Overhead Travelling Cranes – Additional Requirements**

#### **8.2.1 Preamble**

Overhead travelling cranes shall comply with the Requirements for All Travelling Cranes and with the additional requirements of this sub-clause.

#### **8.2.2 Hoist, Hoist Trolley, Crane Beam, End Carriage, Crane Rail, Rail Beam and Gantry**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The **hoist** and **hoist trolley** shall travel along the crane beam.

The **crane beam** shall be a steel structure and may consist of more than a single beam. It shall be supported at each end on end carriages.

The **end carriages** at each end of the crane beam shall travel on the crane rails.

The **crane rails** shall be supported on the crane rail beams. These beams shall be of hot dip galvanised steel unless the drawings indicate that they are of reinforced concrete. If the beams are of reinforced concrete, they will be provided by others, but the Contractor shall timeously submit the requirements for fixing and installation of the crane rails to the Engineer and shall be responsible for performing this work.

The **rail beams** shall be supported on the gantry. The **gantry** shall be founded on the ground.

### 8.2.3 Control Pendants

Electrical control pendants shall be arranged to move independently along the length of the crane beam and shall hang to one metre above operating floor level.

Independent radio control modules are also acceptable on condition that all operating functions are also provided on a suitably located wall mounted control panel.

### 8.2.4 Maintenance Platform and Ladder

Overhead travelling cranes which have a SWL of above 3 000 kg shall be provided with a platform for maintenance. The platform shall span the full length of the crane beam and shall be designed for at least two people.

The crane beam structure shall incorporate welded brackets onto which the platform shall be bolted, i.e. the platform shall be removable and shall not be welded to the crane beam. The platform floor shall have a minimum width of 500 mm and shall comply with Mech 0001. Guard rails shall be provided on the platform and shall comply with Mech 0001. The complete platform and all guard-railing shall be hot-dip galvanised after fabrication.

A hot-dip galvanised, fixed steel ladder shall be provided at a suitable position within the building for accessing the platform on the crane. This shall comply with Mech 1001.

The design shall ensure that persons on the platform cannot be injured by crane movement.

## 8.3 Goliath and Semi - Goliath Cranes – Additional Requirements

### 8.3.1 Preamble

Goliath and Semi-Goliath cranes shall comply with the Requirements for All Travelling Cranes and shall comply with the additional requirements of this sub-clause.

### 8.3.2 Requirements



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Goliath and Semi-Goliath cranes shall be provided with an operator's cab which is mounted on the crane. All controls in the cab shall be of the "dead man's handle" type.

The cab shall be provided with a platform which will allow inspection of the hoist and cross travel. A ladder shall be provided on one of the legs of the goliath crane in order to provide safe access to the cab and platform. The ladder shall comply with Mech 1001.

The position of the cab, platform and ladder shall be decided in conjunction with the Engineer.

A cow catcher shall be provided at each wheel. These shall be designed to push a person's foot and, thereby, prevent injury during movement of the crane. They shall incorporate a flat, horizontal top surface onto which a person can climb if required.

Rails shall be provided with a protective cage at each end so that vehicular access is blocked. During movement of the crane along the rails, a warning buzzer shall sound.

If counterweights are required in order to stabilise the crane under the test load at the limits of travel, then these shall be of solid material, i.e. water ballast is not acceptable. If the counterweight is bolted on, then it shall be of metal or of reinforced concrete slabs.

## 9.13 Hoists

### 9.1 Preamble

Hoists, including crane mounted hoists, shall comply with the General Requirements for All Lifting Equipment and with the additional requirement of this Clause.

### 9.2 General

Hoists shall be provided with an overload prevention device.

The bottom hook shall swivel on a ball or roller bearing through 360° and the bearing shall have a protective skirt. Bearing design shall be fail-to-safe ("drop stop"). The hook shall be fitted with a safety latch.

Chain boxes shall be provided for holding unloaded lengths of load chain and these shall be provided with drain holes.

### 9.3 Manual Hoists

The operating chain shall be as short as feasible in order to prevent entanglement with the lifting chain. The hoist shall hold the load stationary during both lifting and lowering operations if the operating chain is released.

### 9.4 Powered Hoists

Powered hoists shall comply with applicable aspects of the Driven Machinery Regulation 18 of the

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Contractor

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Employer

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## Occupational Health and Safety Act.

Lifting chain is preferred for hoists of up to 5 tonnes but corrosion-protected steel wire rope is acceptable where appropriate.

Wire rope hoists shall comply with the following:

- a) Drum diameter shall be at least 25 times the wire rope diameter.
- b) Drums shall have no more than three layers of wire rope when fully wound up.
- c) Drums shall have no fewer than three full turns of wire rope remaining when the hook is at the lowest level.

Powered hoists shall hold the load stationary upon power failure.

## 10. Manual Hoist Trolleys

### 10.1 Preamble

Manual Hoist Trolleys shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

### 10.2 Requirements

Manual hoist trolleys shall have chain/gear operated movement.

The operating chain shall be as short as feasible in order to prevent entanglement.

## 11. Crawl Beams

### 11.1 Preamble

Crawl Beams shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

### 11.2 Requirements

Crawl beams shall be standard hot rolled I-Sections or standard hot rolled H-Sections.

Crawl beams shall be hot-dip galvanised after all fabrication is complete. If the steel is exposed after galvanising by drilling or welding or any other activity, the complete beam shall have the zinc removed by abrasive blasting to bare steel and it shall be returned to the galvanisers for hot-dip galvanising.

Crawl beam anchors shall preferably be through bolted. Expanding bolts are acceptable on condition that the loading during testing does not exceed forty percent of the manufacturer's maximum recommended load. Chemical anchor is only acceptable if the load is perpendicular to the anchor.

Crawl beams fastened to steel support structures shall be secured using hot-dip galvanised fasteners.

Fasteners which secure crawl beams shall be provided with spring washers in addition to the flat or fender washer.



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## 12. Davits

### 12.1 Preamble

Davits shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this Clause.

### 12.2 Requirements

Davits shall be column mounted with swivelling booms. Where specified, each davit shall be provided with a winch rigidly bolted to the davit. If hand cranked, the winch shall be provided at a convenient height and position for operation.

The davit shall be designed for a SWL at least 100 % above the maximum load requirements.

The davit shall be manufactured of LDX 2101 or of EN Grade 1.4401 (316), or better, or of hot dip galvanised carbon steel. All fasteners, pins, shafts, shackles, hooks, etc., shall be of EN Grade 1.4401 (316), or better. Guide pulleys and shafts shall be made of EN Grade 1.4401 (316) or other accepted corrosion resistant material and shall use self-lubricating bearings.

The slewing arrangement shall be properly designed for easy operation, shall be accurately fitted and shall not be subject to corrosion. Bushes made of nylon, "Vesconite" or other suitable non-metallic material shall be used, and any metallic mating face shall be of stainless steel. The distance between bushes shall be at least one third of the total height of the davit above its footing.

Operating levers, locking arrangements, fixing arrangements, etc., shall not present a hazard. If necessary, operating levers shall be hinged so that they can be swung out of the way when not in use.

Guide pulleys shall be provided to suit the arrangement. The pulley effective diameter shall be not less than 25 times the wire rope diameter. These pulleys shall be machined with a groove having a radius 5 % to 7,5 % greater than the rope radius. The groove depth shall be twice the rope diameter or greater.

## 13. HAND CRANKED WINCHES

### 13.1 Preamble

Hand Cranked Winches shall comply with the General Requirements for All Lifting Equipment and shall comply with the additional requirements of this clause.

### 13.2 Requirements

Hand cranked winches shall be rated for a SWL of at least 100 % in excess of the maximum working load. All gears, clutches, etc., shall be enclosed in a robust cast iron, cast steel or fabricated stainless steel casing which shall be grease filled and sealed against ingress of dirt and moisture.

The winch shall hold the load stationary when the hand crank is released during both raising and lowering. In addition, an operator controlled positive locking arrangement to lock the position of the load at any point shall be provided. A simple ratchet alone is not adequate.



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The force required to operate the winch when lifting its test load shall not exceed 110 Newtons.

The wire rope shall be of stainless steel. The wire rope shall be long enough to reach the lowest required position and still have at least 3 turns remaining on the drum. The drum size shall easily store the full rope length. The drum shall have a diameter of at least 25 times the diameter of the wire rope.

Swaging of cables using crimped metal sleeves is preferred to clamping. Clamped cables shall be provided with at least three clamps. Cable ends shall be secured against fraying.

The support brackets, all exposed fasteners, shafts, handles, pins, etc., shall be of EN Grade 1.4401 (316) stainless steel, or better.

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## SPECIFICATION: MECH 7023: PIPE COUPLINGS

### 1. Introduction

Mech 7023 specifies the requirements for pipe couplings to be provided by the Contractor.

Pipe couplings shall be provided where misalignment or dismantling must be allowed for and for possible pipe movement from settlement, vibration or other cause.

### 2. Scope of Works

This Specification covers the design and manufacture of pipe couplings required along steel pipes for the reservoir and rising main pipework for this Contract. The general arrangement and details of these pipe supports are shown on the drawings.

The pipe supports required inside the pump station for this Contract, and which form part of the contractor's design

### 3. Normative References

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Mech 7023).
- b) Mech 0001: General Mechanical Requirements.
- c) Mech 0003: General Corrosion Protection for Pipelines, Pump Stations and Water Works

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

### 4. Equipment Eligibility

The couplings provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Couplings which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

### 5. Performance Requirements

The coupling shall provide a flexible joint between the two items being connected. The coupling shall withstand the pipework pressure rating.

### 6. Design and Construction

#### 6.1 General

The coupling shall have the same pressure rating as its pipework.

Where the type of coupling is not indicated on the drawing, pipe couplings may be of the mechanical type



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(VJ coupling or flange adaptor), of the stainless steel bellows type or of the rubber bellows type but, in each case, the type chosen shall be suitable for the duty.

Restraints shall only be provided where required. Restraints shall incorporate three tie bars or more.

## 6.2 Mechanical Couplings

Mechanical couplings shall be of the rubber ring compression type (i.e. VJ-type flange adaptors or VJ type couplings) and shall be provided in pairs in order to accommodate axial misalignment and/or settlement. All fasteners, including studs welded to flanges, shall be of stainless steel. Metal castings shall be of ductile iron or of stainless steel.

Couplings for stainless steel and 3CR12 pipework shall be fully of EN Grade 1.4401 (316) stainless steel construction (except for the seal).

## 6.3 Rubber Bellows Couplings

Suitably rated rubber bellows type couplings with metal backing flanges are acceptable for pipe diameters of DN 300 and below.

The bellows shall be provided with two backing flanges drilled to match their mating flanges. Bellows for low carbon steel pipework shall be provided with hot dip galvanised flanges (i.e. not zinc plated). Bellows for 3CR12 or stainless steel pipework shall be provided with matching flange material.

Rubber bellows couplings are not acceptable for bolting directly to the inlet of centrifugal pumps and mechanical couplings shall be used for this application.

## 6.4 Stainless Steel Bellows Couplings

Where stainless steel bellows type couplings are required, the flanges and the flange fasteners shall also be of stainless steel.

## 6.5 Fabrication

Fabrication and welding shall comply with Mech 0001.

## 6.6 Fasteners

Fasteners shall comply with Mech 0001.

## 6.7 Castings

Castings shall comply with Mech 0001.

## 6.8 Corrosion Protection

Corrosion Protection shall comply with Mech 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

## 6.9 Installation

Installation work shall comply with Mech 0001.



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Pipework shall be aligned correctly, and the pipe coupling shall not be used to accommodate visible misalignment in any direction.

#### **6.10 Inspections**

The Contractor shall make arrangements for the Engineer to inspect the couplings for compliance prior to payment being made.

#### **6.11 Testing Requirements**

The correct operation of the couplings and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

### **7. Measurements and Payment**

The rates for the installation of pipes, valves and meters, shall cover the cost of the pipe couplings required complete with anchoring bolts, grouting and gaskets.

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## SPECIFICATION: MECH 7024: PIPEWORK SUPPORTS

### 1. Introduction

Mech 7024 specifies the requirements for supports for pipework to be provided by the Contractor.

### 2. Scope of Works

This Specification covers the design and manufacture of pipework supports required inside the pump stations for this Contract, and which form part of the contractor's design.

### 3. Normative References

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Mech 7024).
- b) Mech 0001: General Mechanical Requirements.
- c) Mech 0003: General Corrosion Protection for Pipelines, Pump Stations and Water Works
- d) Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

### 4. Performance Requirements

Pipe supports shall resist the forces from pressure and from inertial flow changes. The supports shall restrain and support the pipework, valves and other heavy fittings and shall prevent loads and thrust forces from being transferred to pump flanges and other equipment which might be damaged or have shortened lifespans.

Pipework shall accommodate settlement.

Pipework shall be structurally capable of withstanding vibration without fatigue fracture. Vibration shall be restricted to the source and shall not be transferred via pipework.

### 5. Design and Construction

#### 5.1 General

In order to achieve the specified performance requirements, the Contractor shall analyse the forces at isolation valves, check valves, bends and at reducers which are present during normal operation, during dormant conditions, during testing, during start up and during shut down of each pump individually and during operation of the pump station as a whole. The supports shall be designed to transfer all such forces to the concrete structure.

Pipe supports shall be designed and located so that when an item of mechanical equipment, such as a pump or blower, is removed, the associated pipework and equipment is still adequately supported.

Supports shall be provided at or close to all heavy items such as valves of size DN 200 and larger.



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Supports shall be provided so that pipework does not place any external loading on items of rotating mechanical equipment such as pumps, compressors, etc.

Provision shall be made for expansion and contraction due to variations in temperature or pressure.

Pipe supports which only support the weight of horizontal pipework may be of the sliding type and shall be vertically adjustable.

Pipe supports which resist thrust forces shall incorporate doubler plates on the pipe and shall be as short as feasible. The doubler plates shall be of the same or greater thickness than the pipe wall thickness and shall be contoured to match the pipe. Other reinforcing designs will also be acceptable.

Low carbon steel supports shall be fabricated from heavy duty hot rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed. Welds shall be continuous "all round"; i.e. no crevices.

Stainless steel supports shall be fabricated of plate with a minimum thickness of 4,5 mm or shall be fully triangulated, boxed or closed sections. Welds shall be continuous "all round"; i.e. no crevices.

Where appropriate, 3 mm thick neoprene strips shall be placed between pipes and supports or clamps to protect the paintwork and to limit corrosion.

Where roller or sliding supports are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage to the pipe structure from sliding and corrosion.

## 5.2 Supports for Steel Pipework

The maximum allowable spacing between pipe supports for steel (including stainless steel) pipe of diameter,  $d$  [mm], shall be calculated as follows:

$$\text{Spacing (mm)} = 1\,500 + 6d.$$

This applies to pipe only. Valves and other heavy items shall be supported separately.

## 5.3 Supports for Plastic Pipework

The maximum allowable spacing between pipe supports for plastic pipe of diameter,  $d$  [mm], shall be calculated as follows:

$$\text{Spacing (mm)} = (1\,500 + 6d) / 2.$$

This applies to pipe only. Valves and other heavy items shall be supported separately.

## 5.4 Anchoring of Supports

At least four anchor fasteners shall be provided for the foot of each pipe support. Cantilevered pipe supports are not preferred. Their spacing between anchor fasteners on the foot shall be not less than one quarter of the cantilevered length. Gussets between the column and the foot are normally required and these shall be positioned so as to minimise the distance between the gusset and the bolt hole. These requirements do not apply to cantilevered supports which only provide vertical support.

Supports shall be aligned using nuts above the foot and stainless steel shims below the foot. Anchors shall



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be tensioned when their nuts are tightened, i.e. it is not acceptable to use a nut below the base frame to position it; and the holding down force shall be loaded into the concrete structure.

Concrete surfaces under foot plates shall be scabbled before the support is placed and shall be blown clean using compressed air immediately before grouting. A space of at least 20 mm shall be left and this space shall be filled using non-shrink grout once alignment has been completed. Grouting shall be done in accordance with the manufacturer's instructions. Alternative designs and installations may be submitted by the Contractor.

### 5.5 Concrete Supports

Concrete pipe supports are not generally acceptable.

### 5.6 Fabrication

Fabrication and welding shall comply with Mech 0001.

Supports will be inspected by the Engineer after fabrication is complete.

### 5.7 Fasteners

Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

Nuts for anchor fasteners shall be provided with both a spring washer and a flat or fender washer. Fasteners shall comply with Mech 0001.

### 5.8 Corrosion Protection

Corrosion Protection shall comply with Mech 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

### 5.9 Installation

Installation work shall comply with Mech 0001.

### 5.10 Inspections

The Contractor shall make arrangements for the Engineer to inspect the supports for compliance prior to payment being made.

### 5.11 Documents to be Provided

Proposed design of pipe supports, preferably indicated on the General Arrangement design drawings, shall be submitted to the Engineer for review prior to manufacture. Calculations for pipe supports designed to withstand the thrust from reducers, bends and check valves shall also be submitted to the Engineer for review.



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**6. Measurements and Payment**

The rates for the installation of pipes, valves and meters, shall cover the cost of the pipe supports required complete with anchoring.

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**PSE: PARTICULAR SPECIFICATIONS FOR ELECTRICAL REFURBISHMENT AND UPGRADE WORKS**

Contractor

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## PSE - 04: PARTICULAR SPECIFICATION FOR LOW VOLTAGE SWITCHBOARD AND MOTOR CONTROL CENTRES

### 1. Introduction

This specification shall apply to the purchase including design, manufacturing, factory testing, delivery to site, installation, onsite testing and commissioning low voltage (400V) switchboard and motor control centres.

All equipment and services shall comply with the mandatory requirements of the Occupational Health and Safety Act 85 of 1993 and regulations (as amended).

### 2. Scope

#### a. General

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, testing and inspections at works, delivery to site, off-loading, installation, onsite testing, commissioning, and rectification of defects developing during the warranty period.

#### b. Work to be included

- i. Documentation, as called for in the tenderer QA and document requirement list and drawings and data.
- ii. The supply of one complete set of any special tools required per MCC that will be required for operation or maintenance purposes, including three spare sets of each type of fuse.
- iii. Recommended spares for one year's operating and price of same.
- iv. Technical assistance if requested during checking for operational readiness

### 3. Normative References

The following standards and specifications contain provisions that, through reference in the test, constitute requirements of this standard. At the time of this publication the editions indicated were valid. All standards and specification are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards and specification listed below.

- |              |                                                                                           |
|--------------|-------------------------------------------------------------------------------------------|
| • SANS       | - Code of Practice for Wiring of Premises Part 1 – Low-voltage Installations              |
| • SANS 60439 | - Low-voltage Switchgear and Control-gear Assemblies                                      |
| • IEC 60529  | - Degrees of Protection of Enclosures for Low Voltage Switchgear and Control-gear         |
| • SANS 60947 | - Low-voltage Switchgear and Control gear:<br>Pt 1 General rules<br>Pt 2 Circuit breakers |



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Pt 3 Switches/Isolators/Switch Isolators and Combination Fuse  
Switch Units

Pt 4 Contactors

Pt 5 Relay

- IEC 60337 - Low Voltage Control Switches
- IEC 60228 / BSS 159 - Busbars, Main Connections and Small Wiring for Switchgear
- SANS 61643 - Surge Protective Devices Connected to Low-voltage Power Distribution Systems
- IEC 60730-2-7 - Timer Switches
- SANS 61036 - Alternating Current Static Watt-hour Meters for Active Energy (Classes 1 and 2)
- BSS 152 - Electric Power Switchgear and Associated Apparatus
- BSS 158 - Marking and Arrangement for Switchgear Busbars Main Connections of Auxiliary Wiring
- SANS 1091 - National Colour Standards for Paint
- IEC 60185 / BSS 3938 - Current Transformers
- IEC 6043 / BSS 37 - Meters
- IEC 6051 / BSS 89 - Indicating Instruments
- SANS 156 - MCB's and MCCB's
- SANS 1995 - Busbars
- BSS 1767 - Grommet

Wherever the term goods, material and/or equipment is used it shall mean new, unused and of the most recent or current models, incorporating all recent improvement in design and material tested in accordance with the required standard.

#### 4. Definitions and Abbreviations

The following definitions and abbreviations in the above documents shall apply to this standard.

- LNW - Lepelle Northern Water
- SMMMS - Sigodi Marah Martins Management Support



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- NRS - National Rationalisation of Specifications
- SANS - South African National Standards
- IEC - International Electrotechnical Commission
- IEEE - Institute of Electrical and Electronic Engineers Inc.
- BS - British Standards
- AC - Alternating Current
- DC - Direct Current
- GA - General Arrangement
- FAT - Factory Acceptance Test
- FDS - Functional Design Specification
- SAT - Site Acceptance Test
- UPS - Uninterrupted Power Supply
- MCC - Motor Control Centre
- A - Amperage
- V - Voltage
- ACB - Air Circuit Breaker
- MCCB - Moulded Case Circuit Breaker
- MCB - Miniature Circuit Breaker
- CT - Current Transformer

## 5. Design Criteria and Material of Construction

### System Details

Busbar voltage 400V  $\pm$ 10%  
Phase 3  
Frequency 50 Hz  
Phase Rotation R-Y-B-R (Clockwise)

### **Note:**

The fault levels as indicated on drawings shall be deemed to be the maximum occurring at the MCC and Switchboard 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 to be a minimum of one (1) second.



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Employer



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## 6. Manufacturing and Construction Details

### a. Mechanical Construction – General

- i. The MCC or Switchboards shall be fixed pattern, comprising one or more fully interchangeable modular, rigid, free standing/wall mounted sections, bolted together to form an extensible, composite, rigid, free standing/wall mounted and vermin proof MCC or Switchboard of uniform appearance. Each section shall be divided vertically into panels. Each panel shall be divided into one or more cubicles one above the other.
- ii. For floor standing MCC or Switchboards the following shall be applicable:
  - o A channel iron frame (minimum 100mm x 50mm) shall be provided under each completed section of transportable length which shall be so constructed that it can be used for lifting the transportable section without distortion taking place. The maximum length of the transportable sections shall not exceed 3000mm.
  - o All completed sections shall be provided with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.
- iii. The MCC or Switchboards shall be compartmentalised to segregate busbar, cable, circuit-breaker and instrument zones, in such a manner that prospective damage resulting from electrical faults will be minimised and confined to the zone cubicle or compartments in which the fault occurs. Power busbars shall be completely separated from any other compartment by means of suitably earthed metallic barriers.
- iv. Separate compartments shall be provided for each circuit breaker and instrument section.
- v. Access to all power busbar compartments shall be by removable bolted covers removable covers shall be provided with captive screws.
- vi. Incoming feeder, outgoing feeder, relay, control transformer and metering and instrumentation cubicles shall have doors suitably constructed to ensure rigidity. Doors shall be fitted with robust steel or brass (Barker Nelson 41200 EMB or equivalent) hinges with at least two 6mm square recessed quick close/open latches (Barker Nelson 26013 Din lock or equivalent)

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 pad lockable.

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.



Contractor



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Witness 2



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- vii. 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.
- viii. All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.
- ix. Under no circumstances should rear doors have a width exceeding 750mm.
- x. Attention shall be given to ventilation to prevent the accumulation of ionised gases. Suitable drip proof, fine mesh screened, vermin proof openings shall be provided to facilitate air movement by convection. These openings shall be arranged such that the hot gasses or other materials cannot be discharged in a manner injurious to operating personnel.
- xi. 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. Cable entry shall be at the bottom of the board. 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. Gland plates shall be minimum 5mm plate. Gland plates shall be galvanised. The cable gland compartments shall have removable covers attached with standard 6mm square recessed quick close/open latches.
- xii. Suitable termination points shall be provided to enable any multiple three-core cables to be terminated without crossovers of different phases and with minimum lengths of cable "tails". 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 cores after glanding off.

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.

- xiii. Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on the busbar riser section.
- xiv. Spare compartments shall be equipped generally as detailed on the single line diagram, 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.
- xv. The general structure of the board 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.
- xvi. Unless otherwise agreed or stated in this Specification, all screws, bolts and nuts shall be



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Witness 1



Witness 2



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Witness 2

hexagonal to ISO metric commercial standards and shall be rustproof. Loose 'bolts and nuts' shall **not** be used on steelwork. "Avdel Burnside" 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.

- xvii. The switchboard steelwork shall be a minimum of 2mm thick, irrespective of the type of steel used.
- xviii. Each cubicle/compartment door shall be labelled 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 being the tier, numbered from A, left to right and the second the cubicle, numbered from A top to bottom.
- xix. Every door and/or removable cover giving access to a cubicle shall bear a durable designation label suitably inscribed with the description and the equipment number where applicable, using engraved black characters at least 6mm high on white background. Incomers shall be labelled as indicated on the single line diagrams.
- xx. The MCC or Switchboard shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchboard.
- xxi. All removable covers/doors protecting live equipment shall be fitted with warning labels. Warning labels shall be engraved red characters 6mm high on a white background.

Each circuit shall be provided with a blank white/black-white trifoliate type label (or engraved in accordance with designations on drawings).

All electrical components/equipment shall be labelled ((with designations corresponding to those of the Purchaser's schematic diagrams) to facilitate recognition. Engraving shall be left to the discretion of the manufacturer but shall be legible and durable. The component labels shall be affixed adjacent the component they refer to.

All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.

- xxii. Incomers shall be labelled "Incomer from ....."
- xxiii. Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must also be met.
- xxiv. Doors to compartments shall be so arranged that normally they cannot be opened whilst the apparatus contained is live unless this apparatus is fully shrouded or screened to IP20 to prevent inadvertent contact. Doors shall be designed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- xxv. Circuit breakers or isolators shall be interlocked with the panel door to prevent opening of the door when the circuit breaker is in the "ON" position.

A non-apparent interlock defeat shall be provided for the opening of the door with the circuit breaker or isolator in the "ON" position for testing and maintenance. In addition, there shall be provision for the attaching of three padlocks to each operating handle in the "OFF" position, which prevent the circuit breaker or isolator from being operated.

All access doors are to be effectively and permanently earthed to the main panel enclosure of the switchgear, by means of a suitable braided copper earth strap, not less than 35mm<sup>2</sup>, crimped with lugs and bolted at each end to the door and enclosure.

b. Mechanical Construction – Busbar Ducts (where required)

- i. Busbar ducts shall be furnished for the interconnection of the standby bus between the various MCC or Switchboards.
- ii. The bus ducting shall have suitable sealing at each end, between the bus duct and switchgear, and shall be constructed so as to ensure that any fire or other fault cannot spread between the various sections
- iii. Busbar ducts shall utilise copper complying with this Specification and shall have a minimum current rating that will be stated in the drawings. The bus ducts shall be metal enclosed, non-segregated phase type, suitable for indoor use and positively vermin proof. Ventilation slots if any shall be suitably screened with a fine mesh.
- iv. If necessary, provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions.
- v. Busbars, insulators and supports shall be braced so as to withstand the mechanical and thermal effects of the fault current.
- vi. Bus duct housing shall have bolted covers for access to busbars, insulators and joints
- vii. Insulators shall be mounted on their supports in such a way that they can be easily removed and replaced.

c. Electrical Construction

The electrical requirements for each MCC and/or Switchboard shall be as detailed in the drawings

i. **Cooling**



Contractor



Witness 1



Witness 2



Employer



Witness 1



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Artificial cooling of any component will not be acceptable. All design and construction shall be based on natural cooling by convection radiation.

ii. **Busbar and Connections**

Busbars and connections shall generally comply with BS 158, BS 159 and BS 162 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copperwork 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/mm<sup>2</sup>.

Notwithstanding the requirements of BS 159, the following minimum air clearances shall be observed for busbars and other current carrying or live parts:

- Phase – Earth: 30mm
- Phase – Phase: 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed.

In addition, all copperwork (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. Heat shrink insulation shall be used wherever possible.

Main busbars shall be rated current that will be stated in the drawings. Busbar droppers shall be manufactured from solid copper bar and rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rated current that will be stated in the drawings.

The use of flexible conductors as droppers from the main busbars to circuit breakers shall not be permitted.

**Note:**

- Busbars and droppers shall be housed in separate metal enclosures.
- 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.
- 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.
- All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.



Contractor



Witness 1



Witness 2



Employer



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- Power wiring on the "live" side of the circuit breakers (busbar dropper to circuit breaker) shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective breakers and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed so as 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 to be a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.
- This connection may be from insulated stranded conductor, laminated, insulated conductor or multistrand braid.

Notwithstanding the foregoing the minimum power wiring size shall be 25mm<sup>2</sup>. Power wiring terminations shall use an appropriate crimped accessory. The pressed tubular type of accessories is preferred. Stamped, folded, split-barrel type accessories are not acceptable.

In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm<sup>2</sup>

### iii. **Earth Bar**

A continuous copper main earth bar or minimum cross-sectional area 70mm<sup>2</sup> shall extend the whole length of each Motor control centre. This earth bar shall, at least, be bolted to the switchgear housing at each vertical section. Crimp type terminals for 70mm<sup>2</sup> stranded copper shall be provided at both ends of the earth bar for connection of LNW earthing.

### iv. **Wiring**

Each Motor control centre shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transport.

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 <sup>2</sup> phase coloured, common return black insulated, earth link.                |
| General Control Wiring | - | (AC) 1.5mm <sup>2</sup> grey<br>(DC) 1.5mm <sup>2</sup> (positive – red, negative – black)   |
| LED"s and PLC Inputs   | - | (AC) 0.75mm <sup>2</sup> grey<br>(DC) 0.75mm <sup>2</sup> (positive – red, negative – black) |
| Control Neutral        | - | (AC) 2.5mm <sup>2</sup> black                                                                |



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Terminal Links - 2.5mm<sup>2</sup> yellow

Notwithstanding the above-mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions. 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). Control and instrumentation shall not be coloured yellow or blue, yellow or blue being restricted for use as bridge wires and interlocking wires respectively.

All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs unless terminals of the pressure pad type are employed. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Part I and III.

All wiring shall be of the stranded type. Wiring shall be run in plastic trunking. Only where a space problem exists will loomed wiring be acceptable.

**Note:** Stick on harness holders is not acceptable

v. **Wire Numbering**

Cable/wire marking ferrules shall be to the codes laid down in BSS 158 and shall correlate to the appropriate schematic or wiring diagrams.

Split or open type marking ferrules shall not be used

vi. **Terminals**

Minimum rating for terminal blocks shall be 40A. Terminal strips/blocks shall be marked with designations corresponding with the 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. 25% additional spare terminals shall be provided.

Terminals are to be provided for all door mounted components, diodes, etc.

vii. **Circuit Breakers**

Circuit breakers shall be either fixed pattern moulded case circuit breakers or withdrawable pattern air circuit breakers complying with the following requirements:

- Air Circuit Breakers (ACBs)
  - 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.



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- 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.
- Each bus section ACB shall be equipped with three appropriate direct acting non-adjustable over-current trip devices.
- Each incoming ACB from a transformer shall be equipped with three direct acting, thermal inverse time over-current trip devices with adjustable current set point and three direct acting magnetic short time delay over-current trip devices with adjustable current set point and short time delay.
- LNW Engineers shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and downstream protective devices.
- Where current and time delay set points on ACBs are adjustable these 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.
- Interlocks shall be provided to ensure the following:
  - that the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open.
  - that the compartment doors cannot be opened should any accessible portion of the ACB frame be energised.
  - that the breaker cannot be closed unless in the fully connected, test or fully disconnected positions.
- Mechanical deterrents shall be provided to inhibit mismatch of ACBs of different ratings.
- 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.
- ACBs employed as incomers and bus-section switches shall incorporate mechanical interlocks to prevent paralleling of incoming supplies.
- 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



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releases for closing.

- The ACB control/protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.
- Moulded Case Circuit Breakers (MCCBs)
  - MCCBs shall be of the manually operated trip free type with thermal and instantaneous magnetic trips in each pole. Trip functions shall be resettable via the MCCB toggle. Generally, these MCCBs will be used for the incoming circuit breakers and outgoing feeders up to a maximum rating of 800 amps.
  - Each MCCB shall be fitted with a varidepth type operating handle.
  - The thermal trip elements of each MCCB shall be calibrated for the maximum ambient temperature at 40°C
  - Current ratings of MCCBs shall be detailed in the drawings.
  - MCCBs shall be selected according to rating and fault level.
  - The name of the manufacturer shall be furnished by the tenderer at tender stage.
  - 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.
  - Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or Lowe & Fletcher type keys.
  - MCBs shall be confined to auxiliary circuits such as control and indication in which the prospective let through fault current will not exceed 2,5kA. They shall be of the thermal and magnetic trip free type.
  - All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit.
  - 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.
  - All circuit breakers, except bus couplers and incomers, shall be connected with the



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switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".

- The incoming terminals/shutters of all 400V circuit breakers shall be effectively shrouded and marked "400V LIVE" with white characters on a red ground

d. 400V Power Connections

Power connections on any equipment shall not use "Philips"/Star type screw/socket heads. Allen type socket heads are preferred.

e. Insulation Materials

Any insulation, filling putty, etc, used shall be selected such that it can withstand without injurious effect (mechanically or electrically), all temperatures encountered within the switchboard. All ACB boards shall have a surge arrestor fitted to the incoming circuit breaker. This surge arrestor shall be fitted to the LIVE side of the circuit breaker.

f. Instruments and Meters

In general voltmeters and ammeters are a minimum requirement and shall be included as follows:

- Incoming Feeders shall be equipped with 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.
- In addition, incoming feeders shall have a 96mm x 96mm voltmeter connected to measure phase to phase voltage via a set of fuses suitably rated for voltage and short circuit current.
- Outgoing feeders shall be equipped with a suitably sized 5A C T operated 96mm x 96mm 90° movement suppressed maximum ammeter having an overload rating of 40 x rated current for one second.
- CTs shall be rated as follows:
  - Ratio: MCCB Current Rating (A)/5A
  - All CTs shall conform to BS 3938 and IEC 285. For protection purposes class 10P CTs are to be used: for indicating purposes class 1 CTs are to be used and for metering purposes class 0,5 CTs are to be used. In general, CTs mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment. All instruments are to be mounted internally with a protective Perspex or similar, window in the outer door/cover to enable external observation of the instruments.



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viii. **Fuses**

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.

Fuse protection shall be used in cases where capacitive loads are switched i.e. Power factor correction or static capacitors panels.

ix. **Labelling 5mm<sup>2</sup>**

All components shall be clearly labelled with suitable inscriptions indicating their function. All labels shall be affixed by screws and have black lettering on a white ground, except danger labels which shall be white on a red ground.

To prevent confusion, identification labelling must not be placed on removable panels, only the fixed portion of the respective enclosures.

Only safety related labelling must be fixed to removable panels.

x. **Type of Motor Starting**

The following are the types of motor starters available on the market:

- Direct-on-line (DOL) starter
- Star/Delta (S/D) starter
- Soft Starter (SS)
- Variable Frequency/Speed Drive (VFD/VSD)

The type of motor starting required shall be project specific and shall be indicated in the motor control centre schedule/s to be issued by the Engineer.

xi. **Mechanical equipment protection services**

All the protection devices, i.e. motor thermistors, motor heaters, gearbox oil flow switches etc on mechanical equipment shall be accommodated onto the individual motor starter circuit.

xii. **Limit Switches**

Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures. 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.

It shall have high vibration resistance and long mechanical life. It shall have a high protection class that



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would allow the switch to be used in all processes of LNW water treatment or conveyance plants, i.e. actuated valves.

The limit switch shall meet the following minimum requirements:

- Operating ambient temperature -20 °C to +90 °C
- Equipotential bonding External Ex terminals
- Switching capacity 0.16 A at 230 VDC  
6.5A at 230VAC
- Switching point tolerance ±0.5 mm depending on the actuator
- Switching force tolerance ±1 N
- Repeat accuracy ±1 mm
- Protection class IP 67 according to DIN 40050
- Mechanical life 10 000 000 switching cycles
- Vibration resistance 10 g at 10 to 2 000 Hz
- Shock resistance/shock stability 50 g at a shock duration of 6 msec

## 7. Drawings and Documentation

The contractor will supply 3 copies of the equipment drawings and documentation including all items as specified in the Contractor QA and document requirement list.

- All drawings and documentation (operating and maintenance manuals, equipment list, etc.) shall be in accordance with LNW specifications.
- Documentation and drawings will be supplied to LNW within 7 days from delivery, installation, testing and commissioning of equipment, LNW will review the documentation and drawings within 14 days from issue and notify the contractor of its acceptance or rejection of same.

## 8. Painting and Protective Coating

- All chassis plates shall be painted white.
- Specific external colours will be provided by LNW.
- All gland plates shall be galvanised for improved cable earthing

## 9. Performance AND Guarantee

The performance of the items supplied in terms of this specification, as defined by the order, shall be warranted by the contractor and, if specified, be tested in accordance therewith. The contractor shall not be specifically required to conduct a performance test on site. A minimum guarantee period of 12 months is required.



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## 10. Inspection and Testing

LNW agent shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacture of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation. The LNW agent is authorised to reject any items not manufactured to the requirements of the specification. All equipment shall be inspected at the manufacturer's works prior to delivery, to ensure compliance with the specification. No unit shall be considered complete until acceptance by LNW.

The minimum testing / pre delivery check list shall be as follows:

- The LNW representative must carry out a clause-by-clause check of each switchboard and MCC panels, prior to delivery.
- This switchboard and MCC panels list is intended to assist this process but does not relieve him/her of the responsibility described above.

## 11. Detailed Inspection Routine

| Inspection/Testing                                                                                             | Comments |
|----------------------------------------------------------------------------------------------------------------|----------|
| <b>Overall Appearance</b>                                                                                      |          |
| • Paint work                                                                                                   |          |
| • 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.) |          |
| <b>Busbars</b>                                                                                                 |          |
| • Correct cross-section                                                                                        |          |
| • Correct phasing with incomer/outgoers                                                                        |          |
| • Rigidly supported/braced                                                                                     |          |
| • Properly insulated                                                                                           |          |
| • Joints tightened                                                                                             |          |

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|------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <ul style="list-style-type: none"> <li>Transport section joints supplied (fishplates, nuts and bolts, control wiring and terminals, etc.)</li> </ul> |  |
| <ul style="list-style-type: none"> <li>Droppers from main bars to circuit breakers adequately rated, braced, insulated</li> </ul>                    |  |
| <ul style="list-style-type: none"> <li>Nothing unnecessary mounted on bus bars</li> </ul>                                                            |  |
| <ul style="list-style-type: none"> <li>Main earth bar, min 70mm<sup>2</sup></li> </ul>                                                               |  |
| <ul style="list-style-type: none"> <li>Air clearances adequate throughout</li> </ul>                                                                 |  |
| <b>Incoming Circuits</b>                                                                                                                             |  |
| <ul style="list-style-type: none"> <li>Correct size/rating of ACB's or MCCB's</li> </ul>                                                             |  |
| <ul style="list-style-type: none"> <li>Correct metering and proper mounting</li> </ul>                                                               |  |
| <ul style="list-style-type: none"> <li>Connection of power factor meter</li> </ul>                                                                   |  |
| <ul style="list-style-type: none"> <li>Fuses on voltmeter, where applicable</li> </ul>                                                               |  |
| <ul style="list-style-type: none"> <li>Reasonable provision for termination of incoming cable/gland plate</li> </ul>                                 |  |
| <ul style="list-style-type: none"> <li>Air clearances correct throughout</li> </ul>                                                                  |  |
| <b>Outgoing Circuits</b>                                                                                                                             |  |
| <ul style="list-style-type: none"> <li>Correct size/rating for ACB's, MCCB's or MCB's</li> </ul>                                                     |  |
| <ul style="list-style-type: none"> <li>Correct earth leakage relays</li> </ul>                                                                       |  |
| <ul style="list-style-type: none"> <li>Correct current transformer and associated ammeters</li> </ul>                                                |  |
| <ul style="list-style-type: none"> <li>Correct overload relays</li> </ul>                                                                            |  |
| <ul style="list-style-type: none"> <li>Correct setting on overload relays</li> </ul>                                                                 |  |
| <ul style="list-style-type: none"> <li>Reasonable provision for cable termination power and control mounting of equipment</li> </ul>                 |  |
| <ul style="list-style-type: none"> <li>Correct conductor sizing, power and control, and correct colouring</li> </ul>                                 |  |
| <ul style="list-style-type: none"> <li>Correct indicator lights and colours</li> </ul>                                                               |  |
| <ul style="list-style-type: none"> <li>Air clearances correct throughout</li> </ul>                                                                  |  |
| <b>Simulation and Injection Tests</b>                                                                                                                |  |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <ul style="list-style-type: none"> <li>2kV pressure test on all 400V parts of the board, with contactors de-energised and circuit breakers closed, excluding control supply</li> </ul> |  |
| <ul style="list-style-type: none"> <li>Primary injection test for correct operation of all protection and overload relays</li> </ul>                                                   |  |
| <b>Operational Test</b>                                                                                                                                                                |  |
| <ul style="list-style-type: none"> <li>Mechanical operation of all circuit breakers, preferably with doors closed</li> </ul>                                                           |  |
| <ul style="list-style-type: none"> <li>Shunt trip of all circuit breakers</li> </ul>                                                                                                   |  |
| <ul style="list-style-type: none"> <li>Operation of overload relay</li> </ul>                                                                                                          |  |
| <ul style="list-style-type: none"> <li>Correct operation of all interlocks</li> </ul>                                                                                                  |  |
| <ul style="list-style-type: none"> <li>Correct operation of indicating lights/lamps</li> </ul>                                                                                         |  |
| <ul style="list-style-type: none"> <li>Correct operation of earth fault/overload alarm system, including general alarm panel</li> </ul>                                                |  |
| <b>General Checks</b>                                                                                                                                                                  |  |
| <ul style="list-style-type: none"> <li>Marking of control wires and power conductors</li> </ul>                                                                                        |  |
| <ul style="list-style-type: none"> <li>Main Motor control centre label</li> </ul>                                                                                                      |  |
| <ul style="list-style-type: none"> <li>Cubicle labels fitted – designation and cubicle number</li> </ul>                                                                               |  |
| <ul style="list-style-type: none"> <li>Component labels fitted</li> </ul>                                                                                                              |  |
| <ul style="list-style-type: none"> <li>Warning labels on all removable covers giving access to live 400V conductors</li> </ul>                                                         |  |
| <ul style="list-style-type: none"> <li>Labels for indicator lights, pushbuttons, etc.</li> </ul>                                                                                       |  |
| <ul style="list-style-type: none"> <li>Terminal strip labels</li> </ul>                                                                                                                |  |
| <ul style="list-style-type: none"> <li>Incoming side of circuit breakers label</li> </ul>                                                                                              |  |
| <ul style="list-style-type: none"> <li>Incoming circuit label – “FROM _____”</li> </ul>                                                                                                |  |
| <ul style="list-style-type: none"> <li>No Philips (star) and self-tapping screws</li> </ul>                                                                                            |  |
| <ul style="list-style-type: none"> <li>Grommets fitted on all open holes</li> </ul>                                                                                                    |  |
| <ul style="list-style-type: none"> <li>Correct paint specification</li> </ul>                                                                                                          |  |
| <ul style="list-style-type: none"> <li>All documentation submitted</li> </ul>                                                                                                          |  |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

|                                                                     |  |
|---------------------------------------------------------------------|--|
| <ul style="list-style-type: none"><li>Door latches fitted</li></ul> |  |
|---------------------------------------------------------------------|--|

Tender Number: \_\_\_\_\_

Tender's Authorised Signatory:

\_\_\_\_\_

\_\_\_\_\_

Name in block lettersSignature

Full Name of Tendering Company: \_\_\_\_\_

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## EPS - 01: LOW VOLTAGE ELECTRICAL MOTORS

### 1. Scope

This specification shall cover all electric motors to be designed, manufactured, tested at work, supplied installed tested at site and commissioned 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.

### 2. Normative References

The following standards and specifications contain provisions that, through reference in the test, constitute requirements of this standard. At the time of this publication the editions indicated were valid. All standards and specification are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards and specification listed below.

|                    |   |                                                                                              |
|--------------------|---|----------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, Act No. 85 of 1993                                       |
| SANS 10142 - 1     | : | Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020) |
| SANS 1804-2        | : | Low-voltage three-phase standard motors                                                      |
| SANS 60529         | : | Degrees of protection provided by enclosures (IP code)                                       |
| SANS 60034         | : | Rotating electrical machines                                                                 |
| BS 1486-2          | : | Heavy duty lubricating nipples                                                               |
| SANS 60034-1       | : | Rotating electrical machines Part 1: Rating and performance                                  |
| ISO 281            | : | Rolling bearings - dynamic load ratings and rating life                                      |

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |
| BS    | : | British Standards                                     |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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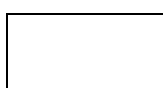
|         |   |                                               |
|---------|---|-----------------------------------------------|
| AC      | : | Alternating Current                           |
| DC      | : | Direct Current                                |
| GA      | : | General Arrangement                           |
| DOL     | : | Direct-On-Line                                |
| TEFC    | : | Totally Enclosed Fan-Cooled                   |
| MCC     | : | Motor Control Centre                          |
| VFD/VSD | - | Variable Frequency Drive/Variable Speed Drive |

#### 4. General Requirements

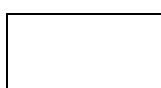
- (a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SANS 1804-2.
- (b) Imported motors shall be accepted only if they form an integral part of the equipment offered. Where imported motors are offered they shall be submitted to the South African Bureau 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.

#### 5. Working Voltage and Supply Systems

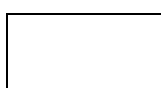
- (a) The motors shall be capable of operating within  $\pm 10\%$  of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage system under actual service conditions, including the  $\pm 10\%$  voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.



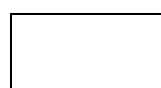
Contractor



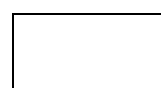
Witness 1



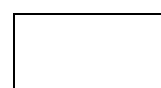
Witness 2



Employer



Witness 1



Witness 2

- (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  $\pm 5\%$  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.

## 6. 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 |

## 7. 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 20kW or more shall not be less than 0,85 under all operating conditions.

## 8. 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.



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## 9. Noise Level

Unless specified differently all motors shall be of 'normal sound power', in compliance with SANS 60034.

## 10. 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.

## 11. 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/VSD'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/VSD'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.

## 12. Rating and Starting Requirements

- i. 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.



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- ii. 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.
- iii. 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.
- iv. 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.
- v. 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.
- vi. 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%.
- vii. Documentation shall include performance curves to suit the designed working conditions.
- viii. 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.

### 13. 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 L10h, basic life rating of 50 000 hours at the rated load and speed for the application in accordance with ISO 281



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#### 14. 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.

#### 15. 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.

#### 16. 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.



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- (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. Pinchscrew 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.

#### 17. 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.



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- (c) The precision tolerance class shall apply to all flange-mounted motors with regard to concentricity, perpendicularity and shaft run-out.

**18. Information Plates for Motors**

In addition to the information required by SABS 948-1 the 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.

**19. Additional Specifications for Multi – Speed Motors**

The following additional specifications apply to all multi-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.

**20. 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



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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.

## 21. 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.

## 22. 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).

## 23. Testing

Tests on completion (commissioning tests) shall be performed as described below in this specification.

### (a) Performance Tests

- 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.



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- 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

(b) Routine Tests

- 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.

(c) Test Certificates

- 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.
- 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.

(d) Witnessing of Tests

All type and routine tests on motors larger than 45 kW shall be witnessed by the Engineer.

(e) Testing of Terminal Box Assembly

- 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.
- These type tests shall have been witnessed by an independent authority.

## 24. 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.



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- (e) For motors of 250 kW and larger fully dimensioned drawings of the shaft showing all tolerances.

## 25. 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.

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- (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.

## 26. Erection and Installation

### (a) Erection

- ix. When motors are erected, care shall be taken to ensure that adequate tolerance margins are made available to ensure interchangeability with replacement motors.
- (ii) A minimum of 10 mm of packers shall be provided under the motor frame or motor bedplate to allow for adjustments in height.
- (iii) 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.
- (iv) The bending radius of the motor supply cable should not be exceeded when installing the cable (SANS10142-1).
- (v) Motor supply cables must be supported and should not hang from the terminal box/gland.

### (b) Bearing Inspection

- (i) The Engineer shall inspect motors having ball/roller bearings.
- (ii) The grease shall be examined to ensure that it is not hard.
- (iii) 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.
- (iv) Should the bearings fail or exhibit the symptoms of brinelling during the guarantee period, the Contractor, free of charge, without delay, shall change them.

### (c) Alignment

- (i) 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.



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Witness 2



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- (ii) 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.
- (d) Drying Out
- (i) 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.
- (ii) 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 60°C but not greater than 80°C for a Class A or 90° 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.
- (iii) The Contractor shall provide all equipment and the personnel required for the drying-out operation.
- (iv) 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.
- (v) Any motor, which fails as a result of being commissioned in a damp condition, shall be repaired at the cost of the Contractor.
- (e) 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.

## 27. 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 be recorded and submitted to the Engineer for approval. The Engineer must be informed timeously off all tests to allow witnessing.



Contractor



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Witness 2



Employer



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## 28. 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:

| <u>Item</u>                         | <u>Unit</u> |
|-------------------------------------|-------------|
| 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.

| <u>Item</u>                                          | <u>Unit</u> |
|------------------------------------------------------|-------------|
| 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

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## EPS-02: LOW VOLTAGE ELECTRICAL CABLE RACKS

### 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.

### 2. Normative References

The following standards and specifications contain provisions that, through reference in the test, constitute requirements of this standard. At the time of this publication the editions indicated were valid. All standards and specification are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards and specification listed below.

|                    |   |                                                                                                  |
|--------------------|---|--------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, Act No. 85 of 1993                                           |
| SANS 10142-1       | : | Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020)     |
| SANS 10044         | : | Welding                                                                                          |
| SANS 10064         | : | Preparation of steel surfaces for coating                                                        |
| SANS 1274          | : | Coatings applied by the powder process                                                           |
| SANS 10162-1       | : | The structural use of steel Part 2: Limit-states design of cold-formed steelwork                 |
| SANS 10162-4       | : | The structural use of steel Part 4: The design of cold-formed stainless steel structural members |

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |
| BS    | : | British Standards                                     |
| AC    | : | Alternating Current                                   |



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DC : Direct Current  
GA : General Arrangement

#### 4. 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

#### 5. Cable Ladder Accessories

##### 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.



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Witness 1



Witness 2



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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 45° metered.

## 6. 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.

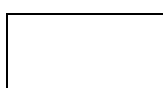
Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

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.

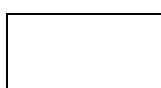
All cable ladders shall be spliced with splice sets. The corrosion protection of splices shall be of the same system as that of the cable ladder.

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.

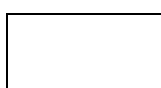
All cable ducting must be covered with anti-theft covers. All exposed cable on cable ladders be covered with anti-theft covers.



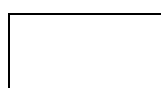
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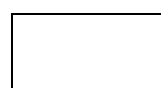
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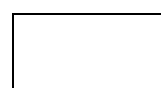
Witness 2



Employer



Witness 1



Witness 2

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

## 7. 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.

## 8. 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:

### Powder Coating System

All cable ladders shall be coated in the colour B26 – orange

- (a) Paint System 1: Powder Coating, seven (7) stage zinc phosphate treatment, pure epoxy primer, polyester finishing coat, thickness 140 µm

| Paint System | Hoist 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                |

- (b) Upon the completion of the corrosion protection specified, the Contractor shall be required to perform the following quality control testing procedures:-



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Impact testing in accordance with SABS 6: Part J,
- Cross hatch adhesion test
- Bend test

(c) 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.

(d) Epoxy Powder Coat Products

| Item | Product type                          | Powder - Lak |
|------|---------------------------------------|--------------|
| 1    | Epoxy primer                          | 23-007       |
| 2    | Pure Epoxy / Polyester finishing coat | Series 3000  |

## 9. 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.

## 10. Measurements and Payment

|                                        |                    |
|----------------------------------------|--------------------|
| <u><b>Item</b></u>                     | <u><b>Unit</b></u> |
| Supply and delivery 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

|                            |                    |
|----------------------------|--------------------|
| <u><b>Item</b></u>         | <u><b>Unit</b></u> |
| 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.

|                    |                    |
|--------------------|--------------------|
| <u><b>Item</b></u> | <u><b>Unit</b></u> |
|--------------------|--------------------|

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

**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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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**

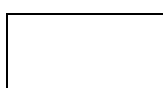
Install reducers (transition-pieces) .....No

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.

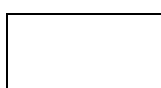
The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the transition-pieces installed under the Contract

**Item** **Unit**

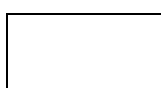
Supply and deliver cable ladder support struts material .....m



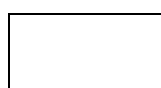
Contractor



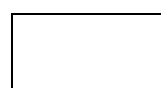
Witness 1



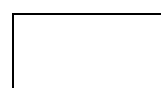
Witness 2



Employer



Witness 1



Witness 2

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 | .....No |

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. T

he 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

ContractorWitness 1Witness 2EmployerWitness 1Witness 2

## EPS-03: ELECTRICAL ISOLATOR PUSHBUTTON STATION (LOCAL START/STOP) EQUIPMENT

### 1. Scope

This section covers the requirements for local isolator/start/stop pushbutton stations. Local isolator/start/stop pushbutton stations shall be supplied, delivered, installed and commissioned for each mechanical equipment driven by a motor.

### 2. Normative References

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

|                    |   |                                                                                                                                                                                                                                                     |
|--------------------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, Act No. 85 of 1993                                                                                                                                                                                              |
| SANS 10142-1       | : | Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020)                                                                                                                                                        |
| SANS 62262         | : | Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)                                                                                                                                 |
| SANS 60529         | : | Degrees of protection provided by enclosures (IP code)                                                                                                                                                                                              |
| SANS 60439-1       | : | Low-voltage Switchgear and Control gear Assemblies Part 1 Type-tested and partially type-tested assemblies                                                                                                                                          |
| SANS 60439-2       | : | Low-voltage Switchgear and Control gear Assemblies Part 2 Particular requirements for busbar trunking systems (busways)                                                                                                                             |
| SANS 60439-3       | : | Low-voltage Switchgear and Control gear Assemblies Part 3 Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards |
| SANS 60947-1       | : | Low-voltage Switchgear and Control gear Part 1 General rules                                                                                                                                                                                        |
| SANS 60947-2       | : | Low-voltage Switchgear and Control gear Part 2 Circuit breakers                                                                                                                                                                                     |
| SANS 60947-3       | : | Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units                                                                                                                             |
| BSI-BS 3858        | : | Specification for Binding and identification sleeves for use on electric cables and wires                                                                                                                                                           |
| SANS 1091          | : | National colour standard                                                                                                                                                                                                                            |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |
| BS    | : | British Standards                                     |
| AC    | : | Alternating Current                                   |
| DC    | : | Direct Current                                        |
| GA    | : | General Arrangement                                   |
| DOL   | : | Direct-On-Line                                        |

### 4. General Requirements

- (a) The enclosure will be manufactured from 3CR12 stainless steel.
- (b) The enclosure will be rated IP65 to SANS 60529 and shall be fitted with a canopy.
- (c) The enclosure shall be painted electric orange (B26).
- (d) The Isolator Pushbutton Station will be equipped with
  - A green flush START pushbutton with spring return. In case of a bidirectional drive a START FORWARD and START REVERSE pushbutton will be installed.
  - A red flush STOP pushbutton with spring return.
  - A red mushroom head EMERGENCY STOP button with mechanical latching, turn to release. The emergency stop pushbutton will be lockable (key reset) and not a padlockable unit. This will not be a lockout point, but will be used for Process use only.
  - A three-pole non-fusible disconnect switch complete with a shaft extension and a door interlocked red and yellow padlockable rotary handle mounted on the door. The current rating of the disconnect switch must match the motor rating as specified in the motor equipment schedule (rated for on-load conditions).
  - All equipment must be installed in one box (power and control
- (d) The Isolator Pushbutton Station will be clearly labelled with an identity label, engraved with 30mm high black on white characters, and shall be mounted on top of the enclosure. The name of the associated drive will be shown.
- (e) All pushbuttons shall be labelled with an identity label, engraved with 10mm high black on white characters and shall be mounted above the pushbutton.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- (f) The Isolator Pushbutton Station shall be mounted within a radius of 1000mm maximum from o the associated drive. If this is not possible, the Engineer will indicate the position of the Pushbutton Station.
- (g) The station shall be pedestal mounted at least 1100mm above floor level. The pedestal design shall be approved by the Engineer.
- (h) The pedestal base plate shall be installed on 10mm of epoxy grout to prevent crack corrosion.
- (i) The pedestal material shall be Stainless steel (3CR12) and have minimum thickness of 6mm. The pedestal shall be painted electric orange (B26).
- (j) The station enclosure shall be designed to provide adequate space for the following: • The required pushbuttons, the disconnect switch and the respective labels.
  - A single multi-core control cable (including glanding) shall be installed from the MCC to the station, from where the required signals shall be individually wired, as per the cable schedule.
  - Power cable/s (including glanding) shall be installed from the MCC to the station, providing power to the associated motor, as per the cable schedule
  - Power cable/s (including glanding) shall be installed from the MCC to the station, providing power to the associated motor, as per the cable schedule

## 5. Dimensions for Isolator Station

The dimensions of the start/stop isolator pushbutton stations shall allow ample space to accommodate all the equipment, taking into account the bending radius of all cables and minimum clearances. The contractor must supply design drawings of the Isolator Pushbutton Station to LNW or their representative for approval prior to manufacturing.

## 6. Fasteners

All fasteners in concrete shall be 316 stainless steel. Pedestal bases shall be sealed against the ingress of any crevice corrosion by means of a suitable non-shrink cementitious grout and approved by the Engineer.

## 7. Measurements and Payment

### Item

### Unit

Supply and delivery of local start/stop isolator pushbutton .....m  
stations

The unit of measure shall be the number of stations supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the local start/stop isolator pushbutton or control stations (as detailed in the schedule of quantities), including support pedestal in accordance with this specification and the additional requirements detailed in the detail specification complete with all mounting brackets.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



| Item                                                           | Unit   |
|----------------------------------------------------------------|--------|
| Install local start/stop isolator pushbutton stations          | .....m |
| The unit of measure shall be the number of stations installed. |        |

The tendered rate shall include full compensation for installing, testing and commissioning of the local start/stop isolator or control stations as specified. The rate shall further include for pedestal support securing and sealing preventing crevice corrosion. Separate items will be scheduled in the schedule of quantities for different types of pushbutton / control stations.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations.

## EPS-04: ELECTRICAL LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES

### 1. Scope

#### (a) 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.

#### (b) Work to be Included

The work includes, but shall not be limited to the items listed below:

- i. All work in (a) above
- ii. Documentation, as called for in the vendor QA and document requirement list and drawings and data.
- iii. The supply of one complete set of any special tools required per Motor control centre that will be required for operation or maintenance purposes, including three spare sets of each type of fuse.
- iv. Technical assistance if requested during checking for operational readiness

### 2. Normative References

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

|                    |   |                                                                                                                     |
|--------------------|---|---------------------------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, Act No. 85 of 1993                                                              |
| SANS 10142-1       | : | Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020)                        |
| SANS 62262         | : | Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code) |
| SANS 60529         | : | Degrees of protection provided by enclosures (IP code)                                                              |
| SANS 60439-1       | : | Low-voltage Switchgear and Control gear Assemblies Part 1 Type-tested and partially type-tested assemblies          |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

|                     |   |                                                                                                                                                                                                                                                           |
|---------------------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SANS 60439-2        | : | Low-voltage Switchgear and Control gear Assemblies Part 2<br>Particular requirements for busbar trunking systems (busways)                                                                                                                                |
| SANS 60439-3        | : | Low-voltage Switchgear and Control gear Assemblies Part 3<br>Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use -<br>Distribution boards |
| SANS 60947          | : | Low-voltage Switchgear and Control gear:<br>Pt 1 General rules<br>Pt 2 Circuit breakers<br>Pt 3 Switches/Isolators/Switch Isolator and Combination Fuse Switch Units<br>Pt 4 Contactors<br>Pt 5 Relays                                                    |
| IEC 60337           | : | Low Voltage Control Switches                                                                                                                                                                                                                              |
| IEC 60228/BSS 159   | : | Busbars, Main Connections and Small Wiring for Switchgear                                                                                                                                                                                                 |
| BSI-BS 3858         | : | Specification for Binding and identification sleeves for use on electric cables and wires                                                                                                                                                                 |
| SANS 1091           | : | National colour standard                                                                                                                                                                                                                                  |
| BSS 142             | : | Protective Relays                                                                                                                                                                                                                                         |
| BSS 1322            | : | Aminoplastic Moulding Materials                                                                                                                                                                                                                           |
| BSS 152             | : | Electric Power Switchgear and Associated Apparatus                                                                                                                                                                                                        |
| BSS 158             | : | Marking and Arrangement for Switchgear Busbars Main Connections of Auxiliary Wiring                                                                                                                                                                       |
| SANS 60076/BSS 3535 | : | Transformers                                                                                                                                                                                                                                              |
| IEC 60185/BSS 3938  | : | Current Transformers                                                                                                                                                                                                                                      |
| IEC 60186/BSS 3941  | : | Voltage Transformers                                                                                                                                                                                                                                      |
| IEC 6043/BSS 37     | : | Meters                                                                                                                                                                                                                                                    |
| IEC 6051/BSS 89     | : | Indicating Instruments                                                                                                                                                                                                                                    |
| SANS 156            | : | MCBs and MCCBs                                                                                                                                                                                                                                            |
| SANS 1995           | : | Busbars                                                                                                                                                                                                                                                   |
| BSS 1767            | : | Grommets                                                                                                                                                                                                                                                  |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |
| BS    | : | British Standards                                     |
| AC    | : | Alternating Current                                   |
| DC    | : | Direct Current                                        |
| GA    | : | General Arrangement                                   |
| DOL   | : | Direct-On-Line                                        |
| MCB   | : | Miniature Circuit Breaker                             |
| MCCB  | : | Moulded Case Circuit Breaker                          |
| ACB   | : | Air Circuit Breaker                                   |
| DB    | : | Distribution Board/Box                                |
| MCC   | : | Motor Control Centre                                  |
| SLD   | : | Single Line Diagram                                   |

### 4. Design Criteria and Material of Construction

#### System Details

Busbar voltage 400Va.c.  $\pm 10\%$   
Phases 3  
Frequency 50 Hz  
Phase rotation R-Y-B-R

#### System Details

Busbar voltage 230Va.c.  $\pm 10\%$   
Phases 1  
Frequency 50 Hz  
Phase rotation N/A

#### Note:

The fault levels as indicated on drawings shall be deemed to be the maximum current occurring at the BD and/or MCC under symmetrical short circuit conditions on the line side of the final limiting device



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

in a circuit. The duration of the maximum short circuit currents shall be deemed to be a minimum of one second. Evidence (in the form of Certificates from testing authorities recognised by LNW) of the ability of the 400/230V distribution switchgear boards offered to withstand satisfactorily the prospective fault conditions shall be furnished with the tender.

## 5. Manufacturing and Construction Details

### (a) Mechanical Construction - General

- i. The DBs/MCCs shall be fixed pattern, comprising one or more fully interchangeable modular, rigid, free-standing sections, bolted together to form an extensible, composite, rigid, free standing and vermin proof DBs/MCCs of uniform appearance. Each section shall be divided vertically into panels. Each panel shall be divided into one or more cubicles one above the other.
- ii. A channel iron frame (minimum 100mm x 50mm) shall be provided under each completed section of transportable length (only applicable to floor standing panels) which shall be so constructed that it can be used for lifting the transportable section without distortion taking place. The maximum length of the transportable sections shall not exceed 3000mm.
- iii. All completed sections shall be provided with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.
- iv. The DB/MCC shall be compartmentalised to segregate busbar, cable, circuit-breaker and instrument zones, in such a manner that prospective damage resulting from electrical faults will be minimised and confined to the zone cubicle or compartments in which the fault occurs. Power busbars shall be completely separated from any other compartment by means of suitably earthed metallic barriers.
- v. Separate compartments shall be provided for each circuit breaker and instrument section.
- vi. Access to all power busbar compartments shall be by removable bolted covers. Removable covers shall be provided with captive screws.
- vii. Incoming feeder, outgoing feeder, relay, control transformer and metering and instrumentation cubicles shall have doors suitably constructed to ensure rigidity. Doors shall be fitted with robust steel or brass (Barker Nelson 41200 EMB or equivalent) hinges with at least two 6mm square recessed quick close/open latches (Barker Nelson 26013 Dinlock or equivalent).

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

latches shall be padlockable. 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.

- viii. (h) 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.
- ix. All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.
- x. Under no circumstances should rear doors have a width exceeding 750mm.
- xi. Attention shall be given to ventilation to prevent the accumulation of ionised gases. Suitable drip proof, fine mesh screened, vermin proof openings shall be provided to facilitate air movement by convection. These openings shall be arranged such that the hot gasses or other materials cannot be discharged in a manner injurious to operating personnel.
- xii. 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. Cable entry shall be at the bottom of the board. 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. Gland plates for three-core cable of cross-sectional area 70mm<sup>2</sup> and above shall be minimum 5mm plate.

Gland plates shall be galvanised. The cable gland compartments shall have removable covers attached with standard 6mm square recessed quick close/open latches.

- xiii. 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". 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 cores after glanding off.

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.

- xiv. Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on the busbar riser section.



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- xv. Spare compartments shall be equipped generally as detailed on the single line diagram, 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.
- xvi. The general structure of the board 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.
- xvii. 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. "Avdel Burnside" 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.
- xviii. The switchboard steelwork shall be a minimum of 2mm thick, irrespective of the type of steel used.
- xix. Each cubicle/compartment door shall be labelled 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 being the tier, numbered from A, left to right and the second the cubicle, numbered from A top to bottom.
- xx. Every door and/or removable cover giving access to a cubicle shall bear a durable designation label suitably inscribed with the description and the equipment number where applicable, using engraved black characters at least 6mm high on white background. Incomers shall be labelled as indicated on the single line diagrams.
- xxi. The DB/MCC shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchgear.
- xxii. All removable covers/doors protecting live equipment shall be fitted with warning labels. Warning labels shall be engraved red characters 6mm high on a white background.

Each circuit shall be provided with a blank white/black white traffolyte type label (or engraved in accordance with designations on drawings).

All electrical components/equipment shall be labelled ((with designations corresponding to those of the Purchaser's schematic diagrams) to facilitate recognition. Engraving shall be left to the discretion of the manufacturer but shall be legible and durable. The component labels shall be affixed adjacent the component they refer to.



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All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.

xxiii. Incomers shall be labelled "Incomer from ....." and the standby bus coupler (where applicable) shall be labelled "Standby Bus Coupler".

xxiv. Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must also be met.

xxv. Doors to compartments shall be so arranged that normally they cannot be opened whilst the apparatus contained is live, unless this apparatus is fully shrouded or screened to IP20 to prevent inadvertent contact. Doors shall be designed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.

xxvi. Circuit breakers shall be interlocked with the panel door to prevent opening of the door when the circuit breaker is in the "ON" position.

A non-apparent 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 the attaching of three padlocks to each operating handle in the "OFF" position, which prevent the circuit breaker from being operated.

All access doors are to be effectively and permanently earthed to the main panel enclosure of the switchgear, by means of a suitable braided copper earth strap, not less than 35mm<sup>2</sup>, crimped with lugs and bolted at each end to the door and enclosure.

(b) Busbar Ducts (where required)

- i. Busbar ducts shall be furnished for the interconnection of the standby bus between the various Motor control centres.
- ii. The bus ducting shall have suitable sealing at each end, between the bus duct and switchgear, and shall be constructed so as to ensure that any fire or other fault cannot spread between the various sections.
- iii. Busbar ducts shall utilise copper complying with this Specification and shall have a minimum current rating of 2000 Amps. The bus ducts shall be metal enclosed, nonsegregated phase type, suitable for indoor use and positively vermin proof. Ventilation slots if any shall be suitably screened with a fine mesh.
- iv. If necessary, provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions.



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- v. Busbars, insulators and supports shall be braced so as to withstand the mechanical and thermal effects of the fault current.
- vi. Bus duct housing shall have bolted covers for access to busbars, insulators and joints.
- vii. Insulators shall be mounted on their supports in such a way that they can be easily removed and replaced.
- (c) Electrical Construction

The electrical requirements for each Motor control centre shall be as detailed in the drawings.

i. Cooling

Artificial cooling of any component will not be acceptable. All design and construction shall be based on natural cooling by convection or radiation.

ii. Busbars and Connections

Busbars and connections shall generally comply with BS 158, BS 159 and BS 162 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copperwork 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/mm<sup>2</sup>.

Notwithstanding the requirements of BS 159, the following minimum air clearances shall be observed for busbars and other current carrying or live parts:

- Phase – Earth: 30mm
- Phase – Phase: 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed.

In addition, all copperwork (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. Heat shrink insulation shall be used wherever possible.



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Main busbars shall be rated for as indicated on the SLD. Busbar droppers shall be manufactured from solid copper bar and rated for the maximum possible current (determined by the breaker frame size) in that section.

The use of flexible conductors as droppers from the main busbars to circuit breakers shall **not** be permitted.

**Note:**

- Busbars and droppers shall be housed in separate metal enclosures.
- 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.
- 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.
- All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.
- Power wiring on the "live" side of the circuit breakers (busbar dropper to circuit breaker) shall be **as short as** possible, sized to carry the maximum current continuously of the frame size of the respective breakers and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed so as 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 to be a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.
- This connection may be from insulated stranded conductor, laminated, insulated conductor or multistrand braid.

Notwithstanding the foregoing the minimum power wiring size shall be 25mm<sup>2</sup>. Power wiring terminations shall use an appropriate crimped accessory. The pressed tubular type of accessories is preferred. **Stamped, folded, split-barrel** type accessories are **not** acceptable.

In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm<sup>2</sup>.



Contractor



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### iii. Earth Bar

A continuous copper main earth bar or minimum cross-sectional area 70mm<sup>2</sup> shall extend the whole length of each DB/MCC. This earth bar shall, at least, be bolted to the switchgear housing at each vertical section. Crimp type terminals for 70mm<sup>2</sup> stranded copper shall be provided at both ends of the earth bar for connection of LNW earthing.

### iv. Wiring

Each DB/MCC shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transport.

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.

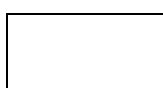
|                        |                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------|
| CT Wiring              | 2.5mm <sup>2</sup> phase coloured, common return black insulated, earth link                 |
| General Control Wiring | (AC) 1.5mm <sup>2</sup> grey<br>(DC) 1.5mm <sup>2</sup> (positive – red, negative – black)   |
| LED's and PLC Inputs   | (AC) 0.75mm <sup>2</sup> grey<br>(DC) 0.75mm <sup>2</sup> (positive – red, negative – black) |
| Control Neutral        | (AC) 2.5mm <sup>2</sup> black                                                                |
| Terminal Links         | 2.5mm <sup>2</sup> yellow                                                                    |

Notwithstanding the above-mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions. 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). Control and instrumentation shall not be coloured yellow or blue, yellow or blue being restricted for use as bridge wires and interlocking wires respectively.

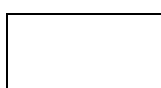
All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs unless terminals of the pressure pad type are employed. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Pt I and III.

All wiring shall be of the stranded type. Wiring shall be run in plastic trunking. Only where a space problem exists will loomed wiring be acceptable.

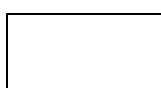
**Note:** Stick on harness holders are **not** acceptable.



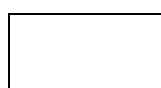
Contractor



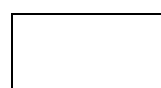
Witness 1



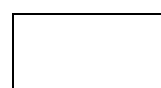
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v. Wire Numbering

Cable/wire marking ferrules shall be to the codes laid down in BSS 158 and shall correlate to the appropriate schematic or wiring diagrams.

Split or open type marking ferrules shall not be used.

vi. Terminals

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. 25% additional spare terminals shall be furnished.

Terminals are to be provided for all door mounted components, diodes, etc.

vii. Circuit Breakers

Circuit breakers shall be either fixed pattern moulded case circuit breakers or withdrawable pattern air circuit breakers complying with the following requirements:

- Air Circuit Breakers (ACBs)
  - 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.  
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 "400/230V – LIVE". ACBs shall be equipped with inter-phase barriers.
  - Each bus section ACB shall be equipped with three appropriate direct acting nonadjustable over-current trip devices.
  - Each incoming ACB from a transformer shall be equipped with three direct acting, thermal inverse time over-current trip devices with adjustable current set point and three direct acting magnetic short time delay over-current trip devices with adjustable current set point and short time delay.



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- The LNW's Consulting Engineer shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and downstream protective devices.
- Where current and time delay set points on ACBs are adjustable these 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.
- Interlocks shall be provided to ensure the following:
  - that the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open.
  - that the compartment doors cannot be opened should any accessible portion of the ACB frame be energised.
  - that the breaker cannot be closed unless in the fully connected, test or fully disconnected positions.
- Mechanical deterrents shall be provided to inhibit mismatch of ACBs of different ratings.
- 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.
- ACBs employed as incomers and bus-section switches shall incorporate mechanical interlocks to prevent paralleling of incoming supplies.
- 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.
- The ACB control/protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.
- Moulded Case Circuit Breakers (MCCBs)
  - MCCBs shall be of the manually operated trip free type with thermal and instantaneous magnetic trips in each pole. Trip functions shall be resettable via the



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MCCB toggle. Generally these MCCBs will be used for the incoming circuit breakers and outgoing feeders up to a maximum rating of as indicated on the SLD.

- Each MCCB shall be fitted with a varidepth type operating handle.
- The thermal trip elements of each MCCB shall be calibrated for the maximum ambient temperature at 40°C.
- Current ratings of MCCBs shall be detailed in the drawings.
- MCCBs shall be selected according to rating and fault level.
- The name of the manufacturer shall be furnished by the tenderer at tender stage.
- 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.
- Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or Lowe & Fletcher type keys.
- Miniature circuit breakers (MCBs) shall be confined to auxiliary circuits such as control and indication in which the prospective let through fault current will not exceed 3kA. They shall be of the thermal and magnetic trip free type.
- All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit. 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. All circuit breakers, except bus couplers and incomers, shall be connected with the switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".
- The incoming terminals/shutters of all 400/230V circuit breakers shall be effectively shrouded and marked "400/230V LIVE" with white characters on a red ground.

viii. 400V Power Connections



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Power connections on any equipment shall **not** use "Philips"/Star type screw/socket heads. Allen type socket heads are preferred.

ix. Insulation Materials

Any insulation, filling putty, etc, used shall be selected such that it can withstand without injurious effect (mechanically or electrically), all temperatures encountered within the switchboard. All ACB boards shall have an surge arrestor fitted to the incoming ACB. This surge arrestor shall be fitted to the LIVE side of the breaker.

x. Instruments and Meters

In general voltmeters and ammeters are a minimum requirement and shall be included as follows:

Incoming Feeders shall be equipped with 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.

In addition, incoming feeders shall have a 96mm x 96mm voltmeter connected to measure phase to phase voltage via a set of fuses suitably rated for voltage and short circuit current.

Outgoing feeders shall be equipped with a suitably sized 5A CT operated 96mm x 96mm 90° movement suppressed maximum ammeter having an overload rating of 40 x rated current for one second.

CTs shall be rated as follows:

| MCCB Current Rating | Ratio |
|---------------------|-------|
| 800                 | 800/5 |
| 700                 | 700/5 |
| 600                 | 600/5 |
| 500                 | 500/5 |
| 400                 | 400/5 |
| 300                 | 300/5 |
| 250                 | 250/5 |



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|     |       |
|-----|-------|
| 225 | 250/5 |
| 200 | 200/5 |
| 150 | 150/5 |
| 100 | 100/5 |
| 75  | 75/5  |
| 60  | 60/5  |
| 40  | 40/5  |
| 30  | 30/5  |

All current transformers shall conform to BS 3938 and IEC 285. For protection purposes class 10P CTs are to be used: for indicating purposes class 1 CTs are to be used and for metering purposes class 0,5 CTs are to be used. In general current transformer mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment. All instruments are to be mounted internally with a protective Perspex or similar, window in the outer door/cover to enable external observation of the instruments.

xi. Specific Notes

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.

Fuse protection shall be used in cases where capacitive loads are switched i.e. Power factor correction or static capacitors panels.

xii. Labelling 5mm<sup>2</sup>

All components shall be clearly labelled with suitable inscriptions indicating their function. All labels shall be affixed by screws and have black lettering on a white ground, except danger labels which shall be white on a red ground.

To prevent confusion, identification labelling must not be placed on removable panels, only the fixed portion of the respective enclosures.

Only safety related labelling must be fixed to removable panels.

xiii. Types of motor starting

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The following are the types of motor starters that available on the market:

- Direct-on-line (DOL) type motor starting
- Star/Delta (S/D) type motor starting
- Soft starting (SS) type motor starting
- Variable Frequency/Speed Drive (VFD/VFD) type motor starting

The type of motor starting required shall be project specific and shall be indicated in the motor control centre schedule/s to be issued by the Engineer.

xiv. Mechanical equipment protection devices

All the protection devices, i.e. motor thermistors, motor heaters, gearbox oil flow switches etc on mechanical equipment shall be accommodated onto the individual motor starter circuits.

xv. Limit Switches

Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures.

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.

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 LNW water treatment plants.

The limit switch shall meet the following minimum requirements:

- Operating ambient temperature
  - -20 °C to +90 °C
- Equipotential bonding
  - External terminals



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- Switching capacity
  - 6.5 A at 250V AC
  - 0.16 A at 230 V DC
- Mechanical data
  - Switching point tolerance
    - +/-0.5 mm depending on the actuator
  - Switching force tolerance
    - +/-1 N E04
  - Repeat accuracy
    - +/-1 mm
  - Protection class
    - IP 67 according to DIN 40050
  - Mechanical life
    - 106 switching cycles
  - Vibration resistance
    - 10 g at 10 to 2 000 Hz
  - Shock resistance/shock stability
    - 50 g at a shock duration of 6 ms

xvi. QA Requirements

| SECTION                                                         | DESCRIPTION                                                         | REQUIRED (YES/NO) | WHEN REQUIRED             |
|-----------------------------------------------------------------|---------------------------------------------------------------------|-------------------|---------------------------|
| Drawings & Design<br><br>(3 Sets of Hardcopies plus 1 Softcopy) | Design Calculations                                                 | Yes               | 3 Weeks after Appointment |
|                                                                 | GA Drawings                                                         | Yes               | 3 Weeks after Appointment |
|                                                                 | Detailed Manufacturing Drawings including Schematic/Wiring Diagrams | Yes               | 3 Weeks after Appointment |



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|                                                    |                                                                          |     |                                    |
|----------------------------------------------------|--------------------------------------------------------------------------|-----|------------------------------------|
|                                                    | Data Sheets                                                              | Yes | 3 Weeks after appointment          |
| Quality Control Documentation                      | Quality Control Plan                                                     | Yes | 3 Weeks after appointment          |
| (3 Sets of Hardcopies plus 1 Softcopy)             | Detailed Program (inclusive of Manufacturing Installation/Commissioning) | Yes | 3 Weeks after appointment          |
| Certificates of Inspection, Testing and Acceptance | Pressure Testing Certificate                                             | Yes | Data Book                          |
|                                                    | Electrical Test Certificates                                             | Yes | Data Book                          |
|                                                    | Instrumentation Calibration Certificate                                  | Yes | Data Book                          |
| Manuals (3 Sets of Hardcopies plus 1 Softcopy)     | Operating and Maintenance Manual                                         |     | 2 Weeks After Practical Completion |
|                                                    | Data Book                                                                |     | 2 Weeks After Practical Completion |
|                                                    | 'As-Built' Drawings                                                      |     | 2 Weeks After Practical Completion |

## 6. Drawings and Data

The tenderer / contractor will supply 4 copies of the equipment data book including all items as specified in the tenderer/contractor's QA and document requirement list.

- (a) All drawings and documentation shall be in accordance with LNW specifications.
- (b) Data books will be supplied to LNW within 7 days from delivery of equipment, LNW will review the data books within 14 days from issue and notify the tenderer/contractor of its acceptance or rejection of same.

## 7. Painting and Protective Coatings

All chassis plates shall be painted white.

Specific external colours will be provided by LNW.

All gland plates shall be galvanised for improved cable earthing.



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Corrosion protection shall conform to the coating system stated below:

#### Powder Coating System

Paint System 1: Powder Coating, seven (7) stage zinc phosphate treatment, pure epoxy primer, polyester finishing coat, thickness 140 µm

| Paint System | Hoist 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                |

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

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.

#### Epoxy Powder Coat Products

| Item | Product type                          | Powder - Lak |
|------|---------------------------------------|--------------|
| 1    | Epoxy primer                          | 23-007       |
| 2    | Pure Epoxy / Polyester finishing coat | Series 3000  |

#### 8. Performance and Guarantee

The performance of the items supplied in terms of this specification, as defined by the order, shall be warranted by the tenderer/manufacturer/contractor and, if specified, be tested in accordance therewith.

The vendor shall not be specifically required to conduct a performance test on site.



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A minimum guarantee period of 12 months is required for which the tenderer/manufacturer shall be responsible to carry out repairs and maintenance during this period defect liability and shall also ensure spares availability during these 12 months period.

## 9. Inspection and Testing

LNW Representative shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacture of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation.

LNW Representative is authorised to reject any items not manufactured to the requirements of the specification.

All equipment shall be inspected at the tenderer's/manufacturer's works prior to delivery, to ensure compliance with the specification

No unit shall be considered complete until acceptance by LNW.

The minimum testing / pre delivery check list shall be as follows:

LNW representative must carry out a clause by clause check of each DB/MCC panel, prior to delivery.

This DB/MCC panel list is intended to assist this process but does not relieve him/her of the responsibility described above.

### • Detailed Inspection Routine

| Inspection/Testing                          | Comments |
|---------------------------------------------|----------|
| <b>Overall Appearance</b>                   |          |
| • Paint work                                |          |
| • 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                     |          |



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| Inspection/Testing                                                                                                                                             | Comments |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <ul style="list-style-type: none"> <li>Equipment supplied in accordance with specification (contractors, overloads, circuit breakers, relays, etc.)</li> </ul> |          |
| <b>Busbars</b>                                                                                                                                                 |          |
| <ul style="list-style-type: none"> <li>Correct cross-section</li> </ul>                                                                                        |          |
| <ul style="list-style-type: none"> <li>Correct phasing with incomer/outgoers</li> </ul>                                                                        |          |
| <ul style="list-style-type: none"> <li>Rigidly supported/braced</li> </ul>                                                                                     |          |
| <ul style="list-style-type: none"> <li>Properly insulated</li> </ul>                                                                                           |          |
| <ul style="list-style-type: none"> <li>Joints tightened</li> </ul>                                                                                             |          |
| <ul style="list-style-type: none"> <li>Transport section joints supplied (fishplates, nuts and bolts, control wiring and terminals, etc.)</li> </ul>           |          |
| <ul style="list-style-type: none"> <li>Droppers from main bars to circuit breakers adequately rated, braced, insulated</li> </ul>                              |          |
| <ul style="list-style-type: none"> <li>Nothing unnecessary mounted on bus bars</li> </ul>                                                                      |          |
| <ul style="list-style-type: none"> <li>Main earth bar, min 70mm<sup>2</sup></li> </ul>                                                                         |          |
| <ul style="list-style-type: none"> <li>Air clearances adequate throughout</li> </ul>                                                                           |          |
| <b>Incoming Circuits</b>                                                                                                                                       |          |
| <ul style="list-style-type: none"> <li>Correct size/rating of ACB's or MCCB's</li> </ul>                                                                       |          |
| <ul style="list-style-type: none"> <li>Correct metering and proper mounting</li> </ul>                                                                         |          |
| <ul style="list-style-type: none"> <li>Connection of power factor meter</li> </ul>                                                                             |          |
| <ul style="list-style-type: none"> <li>Fuses on voltmeter, where applicable</li> </ul>                                                                         |          |
| <ul style="list-style-type: none"> <li>Reasonable provision for termination of incoming cable/gland plate</li> </ul>                                           |          |
| <ul style="list-style-type: none"> <li>Air clearances correct throughout</li> </ul>                                                                            |          |
| <b>Outgoing Circuits</b>                                                                                                                                       |          |
| <ul style="list-style-type: none"> <li>Correct size/rating for ACB's, MCCB's or MCB's</li> </ul>                                                               |          |
| <ul style="list-style-type: none"> <li>Correct earth leakage relays</li> </ul>                                                                                 |          |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

| Inspection/Testing                                                                                                                                                                     | Comments |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <ul style="list-style-type: none"> <li>Correct current transformer and associated ammeters</li> </ul>                                                                                  |          |
| <ul style="list-style-type: none"> <li>Correct overload relays</li> </ul>                                                                                                              |          |
| <ul style="list-style-type: none"> <li>Correct setting on overload relays</li> </ul>                                                                                                   |          |
| <ul style="list-style-type: none"> <li>Reasonable provision for cable termination power and control mounting of equipment</li> </ul>                                                   |          |
| <ul style="list-style-type: none"> <li>Correct conductor sizing, power and control, and correct colouring</li> </ul>                                                                   |          |
| <ul style="list-style-type: none"> <li>Correct indicator lights and colours</li> </ul>                                                                                                 |          |
| <ul style="list-style-type: none"> <li>Air clearances correct throughout</li> </ul>                                                                                                    |          |
| <b>Simulation and Injection Tests</b>                                                                                                                                                  |          |
| <ul style="list-style-type: none"> <li>2kV pressure test on all 400V parts of the board, with contactors de-energised and circuit breakers closed, excluding control supply</li> </ul> |          |
| <ul style="list-style-type: none"> <li>Primary injection test for correct operation of all protection and overload relays</li> </ul>                                                   |          |
| <b>Operational Test</b>                                                                                                                                                                |          |
| <ul style="list-style-type: none"> <li>Mechanical operation of all circuit breakers, preferably with doors closed</li> </ul>                                                           |          |
| <ul style="list-style-type: none"> <li>Shunt trip of all circuit breakers</li> </ul>                                                                                                   |          |
| <ul style="list-style-type: none"> <li>Operation of overload relay</li> </ul>                                                                                                          |          |
| <ul style="list-style-type: none"> <li>Correct operation of all interlocks</li> </ul>                                                                                                  |          |
| <ul style="list-style-type: none"> <li>Correct operation of indicating lights/lamps</li> </ul>                                                                                         |          |
| <ul style="list-style-type: none"> <li>Correct operation of earth fault/overload alarm system, including general alarm panel</li> </ul>                                                |          |
| <b>General Checks</b>                                                                                                                                                                  |          |
| <ul style="list-style-type: none"> <li>Marking of control wires and power conductors</li> </ul>                                                                                        |          |
| <ul style="list-style-type: none"> <li>Main Motor control centre label</li> </ul>                                                                                                      |          |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

| Inspection/Testing                                                             | Comments |
|--------------------------------------------------------------------------------|----------|
| • 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) and self-tapping screws                                    |          |
| • Grommets fitted on all open holes                                            |          |
| • Correct paint specification                                                  |          |
| • All documentation submitted                                                  |          |
| • Door latches fitted                                                          |          |

## 10. Measurements 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 .....no  
Control Centres

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**

Supply and install extra circuits on Switchboards and Motor .....no  
Control Centres

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**

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

| <u><b>Item</b></u>                                                                                                                                                                                                                                                     | <u><b>Unit</b></u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Supply and install siren and alarm light .....                                                                                                                                                                                                                         | 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. |                    |

| <u><b>Item</b></u>                                                                                                                                                                                                                                                                                                                                                                        | <u><b>Unit</b></u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 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 |                    |

| <u><b>Item</b></u>                                                                                                                                                                                                                                                                                                                           | <u><b>Unit</b></u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Add additional circuits to existing boards .....                                                                                                                                                                                                                                                                                             | Lump sum           |
| The unit of measure shall be a lump sum per MCC to which circuits are added.                                                                                                                                                                                                                                                                 |                    |
| The tendered rate shall include full compensation for the supply, delivery, installation, testing and commissioning of the additional circuits specified in the detail specification, for the MCC, including all material, labour and changes to the MCC required to implement the addition of the required circuits to a full working state |                    |

|            |           |           |          |           |           |
|------------|-----------|-----------|----------|-----------|-----------|
|            |           |           |          |           |           |
| Contractor | Witness 1 | Witness 2 | Employer | Witness 1 | Witness 2 |

## EPS-05: ELECTRICAL EARTHING AND LIGHTNING PROTECTION

### 1. Scope

This specification covers the detail requirements of the general protection of low voltage systems against lightning to be installed, 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

### 2. Normative References

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:

|                    |   |                                                                                           |
|--------------------|---|-------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, 85 of 1993                                            |
| SANS 10142-1       | : | The wiring of premises Part 1 – Low voltage installations                                 |
| SANS 62305-1       | : | Protection against lightning Part 1: General principles                                   |
| SANS 62305-2       | : | Protection against lightning Part 2: Risk management                                      |
| SANS 62305-3       | : | Protection against lightning Part 3: Physical damage to structures and life hazard        |
| SANS 62305-4       | : | Protection against lightning Part 4: Electrical and electronic systems within structures. |
| SANS 62561         | : | Lightning protection system components (LPSC)                                             |
| SANS 1063          | : | Earth rods, couplers and connections.                                                     |
| SANS 10199         | : | The design and installation of earth electrodes                                           |
| SANS 10313         | : | Protection against lightning — Physical damage to structures and life hazard.             |

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                         |
|-------|---|-----------------------------------------|
| LNW   | : | Lepelle Northern Water                  |
| SMMMS | : | Sigodi Marah Martins Management Support |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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|      |   |                                                                                                                                                   |
|------|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| NRS  | : | National Rationalisation of Specifications                                                                                                        |
| SANS | : | South African National Standards                                                                                                                  |
| IEC  | : | International Electrotechnical Commission                                                                                                         |
| IEEE | : | Institute of Electrical and Electronic Engineers Inc.                                                                                             |
| LPS  | : | Lightning Protection System                                                                                                                       |
| SPM  | : | Surge Protection Measures                                                                                                                         |
| SPD  | : | Surge Protection Device                                                                                                                           |
| LEMP | : | Lightning Electromagnetic Pulse                                                                                                                   |
| EMC  | : | Electromagnetic compatibility                                                                                                                     |
| LPZ  | : | Lighting Protection Zones                                                                                                                         |
| PE   | : | Protective Earth                                                                                                                                  |
| TN-S | : | Describes an arrangement where separate conductors for Protective Earth (PE) and Neutral (N) are run to consumer loads from a site's power supply |

#### 4. Certificate of Compliance

##### a. 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.

Three hard copies and one soft copy of this report shall be submitted to the Engineer before handing over of any repair, modification or new installation involving LPS or SPM systems.

##### b. Maintenance of installations

LNW 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.

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Contractor

Witness 1

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Employer

Witness 1

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The lightning protection engineer will issue a Lightning Protection System Maintenance Certificate as prescribed in SANS 10313: Annex B, for each area of protection.

## 5. 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.

- c. Protection measures to reduce injury of living beings by electric shock
  - i. Adequate insulation of exposed lightning conductive parts
  - ii. Equipotential bonding of equipment and conductive parts and connection to a meshed earthing system
  - iii. Physical restrictions and warning notices where the above is not achievable.
- d. Lightning Protection System (LPS) to reduce physical damage
  - i. Air-termination system on high points
  - ii. Down-conductor system
  - iii. Earth-termination system
  - iv. Equipotential bonding
- e. Surge Protection Measures (SPM) to reduce failure of electrical and electronic systems
  - i. Earthing and bonding measures
  - ii. Magnetic shielding
  - iii. Line routing
  - iv. Isolating interfaces
  - v. Coordinated Surge Protection Device (SPD) system.

## 6. 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.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

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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.

## 7. External Lighting Protection Systems (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 consists out of an air-termination system, a down-conductor system and an earth-termination system.

### a) 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.

### b) Isolated LPS

On structures at risk of explosion and fire an isolated external LPS must be installed.

### c) Air-termination systems

Air-termination systems can be composed of any combination of the following elements:

- i. Rods (including free-standing masts);
- ii. Catenary wires;
- iii. 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:

- i. Protection angle method;
- ii. Rolling sphere method;
- iii. 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.

### d) Down-conductor systems

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Witness 2

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Witness 2

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.

#### **e) 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  $3\Omega$  (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.

##### **i. 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.

##### **ii. 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).

##### **iii. 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.

##### **iv. 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

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Employer

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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.

#### f) 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.

#### g) Components

All material and components used in a LPS must conform to the requirements specified in SANS 62561.

##### i. Minimum cross-sectional area of conductors

- 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 (mm <sup>2</sup> ) |
|-----------------|---------------|-----------------------------------------|
| Aluminium       | Solid type    | 70                                      |
|                 | Solid round   | 50                                      |
| Stainless steel | Solid tape    | 50                                      |
|                 | Solid round   | 50                                      |



Contractor



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Witness 2



Employer



Witness 1



Witness 2

**Table 1:** Specific configuration and minimum cross-sectional areas of air-termination conductors, air-termination rod and down-conductors

- 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 (mm <sup>2</sup> ) |
| Copper coated steel | Solid round   | 14                      |                                    |
| Stainless steel     | Solid round   | 15                      | 78                                 |
|                     | Solid tape    |                         | 100                                |

**Table 2:** Specific configuration and minimum dimensions of earth conductors and electrodes

## 8. Internal Lighting Protection Systems (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.

### i. Equipotential bonding

All equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

### ii. 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

A ring bonding bar where more than one interconnected bonding bars are installed can be used for larger installations.

iii. 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.

iv. External electrical cables

Live conductors shall be bonded to the bonding bar via SPD's. 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.

v. Telecommunication, control and instrumentation cables

Please refer to Automation and Control Design Standards, Clean Power and Surge Protection.

vi. 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.

vii. 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 components                                                                                             | Material  | Cross-section (mm <sup>2</sup> ) |
|----------------------------------------------------------------------------------------------------------------|-----------|----------------------------------|
| Bonding bars                                                                                                   | Aluminium | 80                               |
| Bonding for LPS                                                                                                | Aluminium | 70                               |
| Connecting conductors from internal metal installations to bonding bars (carrying a partial lightning current) | Aluminium | 70                               |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

**Table 2:** *Specific material and cross-section area for bonding components*

**9. Inspection and Maintenance of LPS**

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.

**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:

**a) Touch voltage**

- i. The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- ii. The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- iii. Increasing the contact resistance of the soil to above 100kΩ, or
- iv. The down conductors are insulated against the lightning impulse (100 kV, 1, 2/50 μs impulse withstand voltage).

**b) Step voltage**

- i. The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- ii. The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- iii. Increasing the contact resistance of the soil to above 100kΩ, or
- iv. The down conductors are insulated against the lighting impulse (100 kV, 1,2/50 μs impulse withstand voltage), or
- v. The installation of a meshed earth-termination system.

**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).

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Witness 2



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.

**a) 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.

**b) 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.

**c) Magnetic shielding and line routing**

Spatial shielding is used to define protection 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.

**d) Coordinated SPD system**

Please read this section in conjunction with the document Automation and Control Design Specifications 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 LPZ<sub>n</sub> is the overall protection zone which borders the inner zone LPZ (LPZ<sub>n+1</sub>). 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 UW 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.

**e) Types of SPD's:**

There are three types of SPD's:

i. Type 1 SPD

The Type 1 SPD is recommended in the specific case of 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  $\mu$ s current wave.

ii. 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  $\mu$ s current wave.

iii. 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  $\mu$ s) and current waves (8/20  $\mu$ s).

**f) SPM management**

A Management Plan must be implemented by a competent and experienced SPM design engineer:

- i. Risk analysis;
- ii. SPM planning;
- iii. SPM design;
- iv. Installation of the SPM;
- v. Approval of the SPM;
- vi. Recurrent inspections (documented);
- vii. Maintenance (following defects noted during recurrent inspections).

**12. Earthing of LV Distribution Systems**

a) 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.

b) Requirements of the TN-S system earthing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- i. 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.
- ii. 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.
- iii. In a three-phase TN-S system, all power cables will be four core, with the fourth (black) core used as the N conductor.
- iv. 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.
- v. The PE conductor should be of copper not less than 10mm<sup>2</sup>.
- vi. The minimum cross-sectional area of the PE conductor for phase conductors 16mm<sup>2</sup> to 35mm<sup>2</sup> is 16mm<sup>2</sup>.
- vii. The minimum cross-sectional area of the PE conductor for phase conductors above 35mm<sup>2</sup> is at least 50% of the phase cross-sectional area.
- viii. No mechanism (circuit breaker, disconnecter, fuse or removable link) which can separate the neutral conductor from the neutral point may be installed.

c) Installation of the TN-S system earthing

- i. The PE conductor will be installed next to the associated LV power cable.
- ii. Where the PE conductor is installed directly in the ground, bare copper earth wire will be used.
- iii. 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

### 13. Measurements and Payment

| <u>Item</u>             | <u>Unit</u> |
|-------------------------|-------------|
| 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

| <u>Item</u>                                   | <u>Unit</u> |
|-----------------------------------------------|-------------|
| 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.

| <u>Item</u>                     | <u>Unit</u> |
|---------------------------------|-------------|
| Installation of a structure LPS | .....Sum    |

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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.

| <u>Item</u> | <u>Unit</u> |
|-------------|-------------|
|-------------|-------------|

|                                               |         |
|-----------------------------------------------|---------|
| 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.

| <u>Item</u> | <u>Unit</u> |
|-------------|-------------|
|-------------|-------------|

|                                                                                                                                                                                    |         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 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.

| <u>Item</u> | <u>Unit</u> |
|-------------|-------------|
|-------------|-------------|

|                                               |                      |
|-----------------------------------------------|----------------------|
| 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

| <u>Item</u> | <u>Unit</u> |
|-------------|-------------|
|-------------|-------------|

|                  |         |
|------------------|---------|
| 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.

## EPS-06: ELECTRICAL LOW VOLTAGE AND CONTROL CABLES

### 1. Scope

This specification covers the requirements with regards to the manufacture, supply, delivery, installation, testing and commissioning of power and control cables rated up to 600/1000V. The term cable shall indicate electrical conductors or carriers manufactured for supplying power for the control and supervision of multipurpose loads

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## 2. Normative References

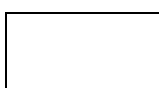
The latest edition, including all amendments up to date of tender of the following particular national and international specifications, publications and codes of practice which shall be read in conjunction with this specification and shall be deemed to form part thereof:

|                    |   |                                                                                                                       |
|--------------------|---|-----------------------------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, 85 of 1993                                                                        |
| SANS 10142-1       | : | The wiring of premises Part 1 – Low voltage installations                                                             |
| SANS 1507          | : | Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)      |
| SANS 1411          | : | Materials of insulated electric cables and flexible cords                                                             |
| SANS 1520          | : | Flexible electrical cables for use in mines                                                                           |
| SANS 10198         | : | The selection, handling and installation of electric power cables of rating not exceeding 33 kV                       |
| IEC 60245          | : | Rubber insulated cables                                                                                               |
| IEC 60287          | : | Electric cables - Calculation of the current rating                                                                   |
| IEC 60811          | : | Electric and optical fibre cables - Test methods for non-metallic materials                                           |
| DIN VDE 0250-816   | : | Cables – Wires and flexible cords for power installation<br>– Heat resistant silicone rubber insulated flexible cable |

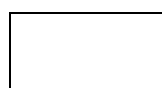
## 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

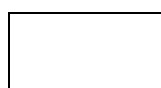
|           |   |                                                                                                                                 |
|-----------|---|---------------------------------------------------------------------------------------------------------------------------------|
| LNW       | : | Lepelle Northern Water                                                                                                          |
| SMMMS     | : | Sigodi Marah Martins Management Support                                                                                         |
| NRS       | : | National Rationalisation of Specifications                                                                                      |
| SANS      | : | South African National Standards                                                                                                |
| IEC       | : | International Electrotechnical Commission                                                                                       |
| IEEE      | : | Institute of Electrical and Electronic Engineers Inc.                                                                           |
| Armouring | : | A layer or layers of galvanized steel wires applied to the cable to provide mechanical protection or earth continuity, or both. |
| Bedding   | : | A layer of extruded compound applied to the cable beneath the armouring.                                                        |



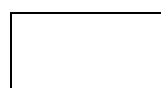
Contractor



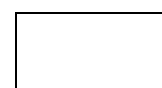
Witness 1



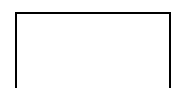
Witness 2



Employer



Witness 1



Witness 2

|                  |   |                                                                                                                                                   |
|------------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Cable            | : | A length of core or more cores assembled, that may or may not be provided with an overall mechanical covering.                                    |
| Direction of lay | : | The lateral direction of inclination to the axis (either left or right) of the receding helix formed by wire or core in a cable or flexible cord. |
| PVC              | : | Polyvinyl chloride                                                                                                                                |
| Sheath           | : | A solid extruded protective covering applied as the exterior of a cable or a flexible cord                                                        |

#### 4. General Scope

##### f. Design and Supply

##### i. Conductor sizes

The minimum conductor size for control cables shall be 2.5mm<sup>2</sup>.

The minimum conductor size for power cables on plant equipment (excluding small power and lighting) shall be 16mm<sup>2</sup>.

##### ii. Conductor material

In the case of plants with a high risk of cable theft, cables with aluminium conductors must be used where the nominal core diameter exceeding 25mm<sup>2</sup>. This must be agreed upon in writing by the Engineer

#### 5. Construction

The cable shall be constructed as follows:

##### a) Conductor Material

The copper conductors shall be of plain annealed or hard draw wire in accordance with the requirements of the latest edition of SANS 1411.

The aluminium conductors shall be of plain hard drawn aluminium wire in accordance with the requirements of the latest edition of SANS 1411.

##### b) Insulation

The insulation material shall comprise of PVC in accordance with the requirements of the latest edition of SANS 1411.

##### c) Core Colour Identification



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The cable cores colour shall be in accordance with the requirements of the latest edition of SANS 1507-3.

d) Bedding

The bedding shall consist of a continuous PVC extruded sheath.

e) Armour

The armouring shall consist of one layer of round galvanised steel wire in accordance with the requirements of the latest edition of SANS 1411.

f) Sheath

The outer sheathing shall be an impermeable, halogen free, reduced smoke emission, flame retardant PVC in accordance with the latest edition of SANS 1411.

**6. Cable Markings**

The cables shall be legibly marked in accordance with the requirements of the latest edition of SANS 1507, and shall include the following:

- a) Conductor size in square millimetres
- b) Number of cores
- c) Conductor material (copper)
- d) The specification number (SANS 1507) to which the cable has been manufactured.
- e) The year of manufacture.
- f) Nominal voltage

**7. Storage**

Cables shall be packed on reeled drums. The moisture content of wooden cable drums shall not exceed 20%.

Each end of the cable shall before being secured to the reeled drum, be sealed by an acceptable method approved by the Engineer. The outer end shall be secured to the reel drum and the inner end shall be protected in a manner against mechanical damage.

The cable reeled drums shall be capable of taking a round spindle and be lagged with strong, closely fitted battens, at the inner and outer circumference to prevent damage to the cables. The spindle bearing plates shall be steel. The dimensions of the drum shall not exceed 1 100 mm width, 2 000 mm diameter and the spindle bearing plate shall not be less than 9 mm thick. Each drum shall be clearly marked on both sides in accordance with the latest edition of SANS 1507.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



The ends of the PVC sheathed cable shall be sealed to avoid penetration of moisture. Each cable drum shall be numbered.

#### 8. Cable Sizing and De-Rating

The cables shall be sized and de-rated in accordance with the requirements of the latest edition of SANS 10142-1.

#### 9. Testing of Cables

##### a) 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:

- i. SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

| SANS 1507<br><br>Test | Duration (min) | Commissioning test voltage between conductors (V) |          |           | Commissioning test voltage between conductors/earth (V) |          |           |
|-----------------------|----------------|---------------------------------------------------|----------|-----------|---------------------------------------------------------|----------|-----------|
|                       |                | 300/500                                           | 600/1000 | 1900/3300 | 300/500                                                 | 600/1000 | 1900/3300 |
| AC (rms)              | 15             | 1000                                              | 2000     | 6000      | 1000                                                    | 3000     | 3500      |
| DC                    | 15             | 1500                                              | 3000     | 9000      | 1500                                                    | 3000     | 5000      |

This test will be conducted to the Engineers judgement. The constructor must obtain written approval from the Engineer before conducting any tests.

#### 10. Quality Assurance

All the cables supplied under the Scope of Works of this project shall be designed and



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

manufactured under a quality control system, typically to ISO 9000 series. The contractor must supply current compliance certificates on the manufacturers ISO classification.

## 11. Measurements and Payment

| <u>Item</u>                                    | <u>Unit</u> |
|------------------------------------------------|-------------|
| Supply and delivery of low-voltage cable ..... | m           |

The unit of measurement shall be the length of low-voltage cable supplied. It is the responsibility of the Contractor to verify the lengths of cables required on site. The Contractor shall only supply the required length of cables required. The final quantity of installed cable lengths shall determine the final quantity to be paid of the supplied cable lengths.

The tendered rate shall include for the design, manufacture, supply and delivery of the specified cable to the site.

Separate items shall be scheduled under this payment item for each size and type of cable.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## EPS-07: ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKETS OUTLETS

### 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.

### 2. Normative References

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:

|                    |   |                                                                                                                                                                    |
|--------------------|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, 85 of 1993                                                                                                                     |
| SANS 10142-1       | : | The wiring of premises Part 1 – Low voltage installations                                                                                                          |
| SANS 1222          | : | Enclosures for electrical equipment classified by IP code                                                                                                          |
| SANS 6309          | : | Plugs, socket-outlets and couplers for industrial purposes                                                                                                         |
| SANS 1091          | : | National colour standard                                                                                                                                           |
| 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. |

### 3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |

### 4. 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.

a) Single phase 16A household and similar purpose socket outlet



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Applied to general household, commercial and light industrial installations up to 250Vac 16 A.

- i. Compliance: SANS 164-2/SANS10142-1
- ii. Wall mounted socket;
- iii. Be of the two-pole earthing contact type;
- iv. Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;
- b) Single phase 16A industrial socket outlet
  - v. Wall mounted socket; Pin and sleeve configuration;
  - vi. 2 pole, 3-wire with 2P+E 230V ac, 16A;
  - vii. Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;
  - viii. Ingress protection IP67 (SANS 1222);
  - ix. Switched locally on the socket outlet;
  - x. Mechanical interlock to prevent plugs from being engaged or disengaged under load;
  - xi. Lockable by a padlock (40mm) at the switch-off position.
- c) Three phase 63A industrial welding socket outlet (5-pin)
  - i. Compliance: SANS 60309-1
  - ii. 415Vac 3phase, neutral and protective earth (5 pin), 63A current rating
  - iii. Housing: Powder coated die-cast aluminium
  - iv. Colour: Electric orange RAL B26
  - v. Wall mounted socket with top cable entry with removable flange;
  - vi. Pin and sleeve configuration;
  - vii. 3-phase earth leakage protection unit mounted in the feeder cubicle in the MCC/DB;
  - viii. Rated ingress protection IP55 (SANS 1222);
  - ix. Switched locally on the socket outlet, lockable by a padlock (40mm) at the switch-off position;
  - x. 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
  - xi. 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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<sup>2</sup>, the cable core size from the junction box terminals to the socket outlet shall be 16mm<sup>2</sup>, 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.

## 5. 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.

## 6. Measurements and Payment

| <u>Item</u>                                                                               | <u>Unit</u> |
|-------------------------------------------------------------------------------------------|-------------|
| 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.

| <u>Item</u>                                                            | <u>Unit</u> |
|------------------------------------------------------------------------|-------------|
| 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## EPS-010: ELECTRICAL UNINTERRUPTIBLE POWER SUPPLY UNIT

### 1.3 Introduction

This specification is for the supply and installation of Single Online Double Conversion Static Uninterrupted Power Supply Units (UPS) for use in office and industrial environments.

The UPS Unit will be used for backing up critical electrical loads, such as lighting, dedicated sockets, air conditioning in computer rooms etc.

The UPS Unit will be installed via Normal Power or via a Diesel Standby Generator.

### 1.4 Scope

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, delivery to site, off load, install in position, fix on site, testing, commissioning and inspection of the equipment and installation works at the manufacturer's premises and on site of an UPS Unit and its installation.

The Tenderer has to complete all required returnable schedules. Failure to comply with this request will lead to immediate disqualification.

The Tenderer will be responsible for connecting electrical cables to their own equipment that is supplied and installed under this contract. All cables will be properly glanded to the units.

### 1.5 Normative References

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

|                    |   |                                                                                                                   |
|--------------------|---|-------------------------------------------------------------------------------------------------------------------|
| OHS Act 85 of 1993 | : | Occupational Health and Safety Act, Act No. 85 of 1993                                                            |
| SANS 10142-1       | : | Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020)                      |
| SANS 60439         | : | Low Voltage Switchgear and Control Gear Assemblies                                                                |
| SANS 60947/IEC 947 | : | Low-voltage switchgear and controlgear                                                                            |
| IEC 60146          | : | General requirements and line commutated convert                                                                  |
| IEC 747            | : | Semi-conductor Devices (including Thyristors)                                                                     |
| IEC 60269-4        | : | Low-voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices |
| IEC 60269-5        | : | Low-voltage fuses - Part 5: Guidance for the application of low-voltage fuses                                     |
| SANS 156           | : | Moulded-case circuit-breakers                                                                                     |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



|                   |   |                                                                                           |
|-------------------|---|-------------------------------------------------------------------------------------------|
| IEC 60228/BSS 159 | : | Busbars, Main Connections and Small Wiring for Switchgear                                 |
| BSI-BS 3858       | : | Specification for Binding and identification sleeves for use on electric cables and wires |
| BSS 1322          | : | Aminoplastic Moulding Materials                                                           |
| BSS 152           | : | Electric Power Switchgear and Associated Apparatus                                        |
| BSS 158           | : | Marking and Arrangement for Switchgear Busbars Main Connections of Auxiliary Wiring       |
| IEC 6043/BSS 37   | : | Meters                                                                                    |
| IEC 6051/BSS 89   | : | Indicating Instruments                                                                    |
| SANS 156          | : | MCBs and MCCBs                                                                            |
| SANS 1995         | : | Busbars                                                                                   |
| BSS 1767          | : | Grommets                                                                                  |

## 1.6 Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

|       |   |                                                       |
|-------|---|-------------------------------------------------------|
| LNW   | : | Lepelle Northern Water                                |
| SMMMS | : | Sigodi Marah Martins Management Support               |
| NRS   | : | National Rationalisation of Specifications            |
| SANS  | : | South African National Standards                      |
| IEC   | : | International Electrotechnical Commission             |
| IEEE  | : | Institute of Electrical and Electronic Engineers Inc. |
| BS    | : | British Standards                                     |
| AC    | : | Alternating Current                                   |
| DC    | : | Direct Current                                        |
| GA    | : | General Arrangement                                   |
| MCB   | : | Miniature Circuit Breaker                             |
| MCCB  | : | Moulded Case Circuit Breaker                          |
| SLD   | : | Single Line Diagram                                   |

## 1.7 General Technical Specification

### a) General



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- i. All Single Online Double Conversion Static UPS Units will be continuous duty single or three phase units.
- ii. The UPS must be a TRUE on-line, double conversion transformer-based unit (i.e. using a transformer that 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.
- iii. The UPS must employ PWM technology.
- iv. The UPS must have battery backup for at least 30 minutes at the full rated load of the UPS.
- v. The output waveform shall be sinusoidal in form with the THD at full line load not exceeding 3%.
- vi. The output voltage variation must not exceed 2%.
- vii. Interference shall not exceed the limits laid down by ICASA
- viii. The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.
- ix. 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.
- x. The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.
- xi. The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.
- xii. The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.
- xiii. 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.
- xiv. 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.
- xv. 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.
- xvi. Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering
- xvii. 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.
- xviii. The UPS must be able to operate normally in an ambient service temperature of 0°C to +35°C and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.
- xix. The rated output voltage must be user selectable from 220/230/240V.
- xx. The output frequency must not vary by more than 3Hz.
- xxi. The UPS module shall consist of the following main components:
  - Transformer - choke input stage,
  - Rectifier/Charger and DC link,
  - Static Inverter,
  - Static Bypass Switch and Manual Bypass Switch,
  - Control Panel and Mimic Panel with LCD Display,



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- Output Isolation Transformer,

b) UPS Rating

- 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.
- The UPS efficiency must be no less than 89% from zero to full load.
- 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

c) UPS Backup Batteries

- Tenderers must state the exact number of batteries that will be used.
- Tenderers must state the type of batteries that will be used.
- Tenderers must state the Ah rating of the batteries that will be used.
- Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

d) UPS Standards

- All imported UPSs must have a CE rating
- The UPS must have CE, LGA/GS markings.
- The UPS must comply with safety conformance to EN-50091-1.
- The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2

e) Module Modes of Operation

The UPS unit will operate as an online, fully automatic system in the following modes:-

i. Normal:

- The inverter shall continuously supply the critical load.
- The Rectifier/Charger shall derive power from the commercial AC source and shall supply DC power to the Inverter while simultaneously float charging the batteries.

ii. Batteries:

- Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
- The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.

iii. Recharge:

- Upon restoration of the AC source, the Rectifier/Charger shall recharge the batteries and simultaneously provide power to the Inverter.
- This shall be an automatic function and shall cause no interruption to the critical load.

iv. Bypass:

- No-break transfer to and from Bypass mode shall be capable of being initiated manually, without operation of the static switch



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Witness 1



Witness 2

f) Cabinets/Enclosures

The UPS Unit and the back-up batteries must each be supplied and installed in a freestanding double front steel metal cabinet/enclosure (safety shield behind doors) on adjustable/levelling feet, all pre-powder coated. The cabinets/enclosures shall be designed for industrial and computer room applications in accordance with the environment requirements. The cabinets will have a minimum standard Ingress Protection of 20 (IP20) in office environments and a minimum Ingress Protection of 23 (IP23) in dusty conditions.

Cabinets will be provided with lockable removable doors/panels and seal protection as required. These doors/panels will be cut to accommodate the control panel displays and metering as required. Cabinets must be provided with forced air-cooling ventilation fans. Should the fans be installed on the top section, the cabinets must be fitted with drip trays.

The cabinets must ensure that cable entry and connection will be from the bottom and additional support is provided for cable glands. A dedicated wire way shall be provided within the UPS module for routing user input and output wiring.

UPS Unit plus Battery Cabinet must line up and match up in style and colour.

Service Area Requirements: The UPS module shall require no more than 1 meter of front and side service access room

Refer to Environment Conditions – Cabinets/Enclosures must be built to suit all temperatures and humidity conditions.

Cabinets/Enclosures must be labelled with 50mm high black engraved letters on white background fixed to cabinet with screw in centre of units.

g) Manufacturer's Field Service

i. Field Engineering Support:

- The UPS manufacturer shall have a countrywide field service department staffed by factory-trained field service engineers dedicated to start-up, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location.
- Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours 80% of the time.
- Location of all field service offices must be submitted with the proposal.
- Third-party maintenance will not be accepted.

ii. Spare Parts Support:

- Parts be available within 24 hours.

iii. Operational Training:



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Witness 2



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Witness 2

- Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

iv. Product Enhancement Program:

- The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These products shall be proposed as a field-installable, optional kit.

h) UPS Data Sheets (Returnable Schedule)

The tenderer must complete the data sheet below with his tender:

| DESCRIPTION                                                                          | DATA |
|--------------------------------------------------------------------------------------|------|
| Make/Manufacturer                                                                    |      |
| Type/Model (E.g. true on-line, double conversion)                                    |      |
| Technology employed (E.g. pulse width modulation)                                    |      |
| Transformer-based unit (Y/N?)                                                        |      |
| 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                                                         |      |



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Witness 2



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|                             |  |
|-----------------------------|--|
| Ah rating of batteries      |  |
| Design life of batteries    |  |
| Local agent (Y/N)?          |  |
| Local agent contact details |  |
| Guarantee period            |  |

### 1.8 Qualifications

- The UPS manufacturer shall have a minimum of ten years' experience in the design, manufacture and testing of solid-state UPS. A list of installed UPS of the same type as the manufacturer proposes to furnish for this application shall be supplied with the proposal.
- The UPS manufacturer shall have ISO 9001 certification for engineering/R&D and manufacturing facilities.
- 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.

### 1.9 Guarantee

The successful vendor/supplier will guarantee the installation works and equipment for a period of twelve months after first delivery was taken by the Engineer.

### 1.10 Testing and Inspection

- The testing and inspection procedures shall be approved prior to the commencement of manufacture.
- The Contractor shall assemble the complete UPS for inspection and factory testing, and present the system to the Engineer, to who it shall be demonstrated that the equipment meets the requirements of the specification.
- The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.
- The Contractor shall provide suitably qualified personnel and all necessary equipment to carry out the tests to demonstrate conformance with the specification and simulate the operation of the system in its final operating state.
- The Contractor shall prepare a set of completed test and inspection certificates for approval.
- The contractor is required to perform site acceptance tests (SAT) on the UPS witnessed by the employer and the engineer, prior to commissioning the UPS. A schedule of the checks, tests and results of the SAT must be available for signing by the engineer at the completion of the SAT.
- A thermal imaging record of the UPS shall be taken after the UPS has been in operation for a minimum one week under typical normal conditions and while running. The thermal imaging record will form part of the deliverable documentation together with Operation and Maintenance Manuals and delivered to the employer on completion of the works.

### 1.11 Packing and Marking

- Packing



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Witness 2



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Witness 1



Witness 2

The Contractor shall protect the equipment against scratching and damage by suitable wrapping, packing and crating of the equipment items.

b) Marking

Each separately packed and transported piece of equipment shall be clearly marked

### 1.12 Measurement and Payment

| <u>Item</u>                                                                                                                                                                              | <u>Unit</u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Supply and deliver UPS                                                                                                                                                                   | .....no     |
| The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the UPS incorporating all options/extras as detailed in the detail specification. |             |

| <u>Item</u>                                                                                                                                                                                                               | <u>Unit</u> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Install UPS                                                                                                                                                                                                               | .....no     |
| The tendered rate shall include full compensation for the installation, site testing and commissioning plus the 12 months maintenance of the UPS incorporating all options/extras as detailed in the detail specification |             |

| <u>Item</u>                                                                                                                                                                        | <u>Unit</u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Supply and deliver support platform/stand for UPS                                                                                                                                  | .....no     |
| The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the support platform/stand for UPS as detailed in the detail specification. |             |

| <u>Item</u>                                                                                                                                   | <u>Unit</u> |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Install support platform/stand for UPS.                                                                                                       | .....no     |
| The tendered rate shall include full compensation for the installation of the support platform/stand as detailed in the detail specification. |             |

The tendered rate shall include full compensation for the installation of the support platform/stand as detailed in the detail specification.

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## EPS-011: PARTICULAR SPECIFICATION FOR INSTRUMENTATION

### 1. DESIGN BASIS

#### 1.1 General

This specification covers the design, manufacture, test at works, supply, delivery, installation, test at site and commissioning of control and instrumentation equipment

#### 1.2 Panel Instruments

1.2.1 It should be endeavored not to have any panel instruments, but rather to make use of the PLC / SCADA or DCS. Where panel instruments are required for instance at a T/A set the following shall apply.

1.2.2 Standard size instruments shall be used on the control panels to indicate, record, and control the major portion of the process variables.

1.2.3 Factory assembled panels or field assembled panels shall be furnished in accordance with Item 4.1 of this specification.

1.2.4 Process fluids shall not be piped directly to instruments in the control room.

1.2.5 Where separate electric power supplies are required for electronic instrumentation systems, it shall be taken off the UPS supplying that area Instrumentation.

#### 1.3 Field Instruments

1.3.1 All field mounted instruments shall be weather-proof and dust-tight, suitable for use under ambient conditions prevalent in a specific plant area.

1.3.2 In plant areas giving rise to corrosive atmospheres, field mounted instruments such as transmitters, I/P converters, solenoid valves, pressure switches etc. shall be housed in steel boxes with IP65 rating. Piping and cable entries shall be made at the bottom of the box.

1.3.3 All field boxes will be fitted with canopies.

1.3.4 All valves and drives shall be correctly sized with a 50% turn down ratio.

#### 1.4 Control Performance

1.4.1 Automated production is performed by a distributed process control and information management system comprising supervisory computers and controllers linked to a distributed real-time network.

1.4.2 Automatic control systems shall, in general, be of feedback type, however, feed-forward control shall be used when process time-lag conditions that exist in a feed-back system are not tolerable. Modes of control shall, in general, be proportional (P), proportional plus automatic reset (I), or proportional plus reset plus rate (D).

1.4.3 All control loops shall be stable for all process conditions. Cyclic stability will not be accepted. Final value error shall be minimized whenever practical.

#### 1.5 Metering Base and PCS Units

Pressure above 1 bar - kPa

Pressure below 1 bar - Pa

Draft - mm H<sub>2</sub>O



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Witness 1



Witness 2



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Witness 1



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Vacuum - kPa (abs)  
Temperatures - °C  
Flow (all gases) - m<sup>3</sup> /hr  
Flow (steam and condensate) - kg/hr tonne/hr  
Flow (liquids) - kg/hr lt/hr lt/sec  
Flow base - based at 760mm Hg and 0°C  
Level - %  
Density - kg/m<sup>3</sup>

## 1.6 Utilities

- 1.6.1 Electrical power, available from the plant system is 3 phase 400 V and 1 phase 230 V, 50Hz. If the equipment is required to operate at any other voltage level, the necessary transformer and/or conversion units shall be included in the scope of supply by the Contractor.
- 1.6.2 A power supply calculation shall be performed to determine the capacity of UPS capacity including battery.
- 1.6.3 Standard voltage:
- |                            |   |                       |
|----------------------------|---|-----------------------|
| Main power supply          | - | 3 x 400/230 V 50 Hz   |
| UPS Supply                 | - | 1 x 230 V ± 5%, 50 Hz |
| Instrument Control Voltage | - | 1 x 230 V ± 5%, 50 Hz |
| - 24 V ±5%, DC             |   |                       |
| Digital Signals            | - | 24 V ±5%, DC          |
| Analogue Signals           | - | 4 to 20 mA DC         |
- 1.6.4 Clean instrument compressed air will generally be available, however where specific instruments may require air quality above the normal quality of plant instrument air or at a lower pressure than the plant instrument air the contractor is to ensure that all necessary regulators, dryers, separators and lubricators are allowed for.

## 2. PANEL INSTRUMENT DESIGN

### 2.1 Recorders

Recorders are not preferred, SCADA/DCS trends, i.e., Real Time and History trends should be available for all measured variables.

### 2.2 Controllers

- 2.2.1 Stand-Alone controllers, (panel mount controllers), are not preferred.

### 2.3 Indicators

- 2.3.1 Stand-Alone indicators, (panel mount electronic indicators), are not preferred.

### 2.4 Alarm Annunciator

Alarm display window shall be LED side lighted name plate type.



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Witness 2



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Witness 2

Each alarm system shall be equipped with flasher and horn and shall have provision for pushbuttons to acknowledge, reset and test the system.

Visual alarms shall be located in the vicinity of monitored process conditions on graphics panels. Miscellaneous alarms shall be grouped into a common bank whenever practical. Alarm initiating contacts shall be normally open, either fleeting or permanent type. For the case of power failure or wire break, closed safety circuit operation shall be applied wherever practical.

The response for alarm systems shall be less than 20 milliseconds.

Alarm annunciation systems shall be energized from a secure 24V DC or 220 VAC power supply source (UPS).

Operating sequence of alarm system shall be as follows:

| Condition             | Visual Alarm | Audible Alarm |    |
|-----------------------|--------------|---------------|----|
| Normal                | Off          | Off           |    |
|                       |              |               |    |
| Fault occurs          | Flashing     | On            |    |
| Normal before         |              |               |    |
| Acknowledge           | Flashing     |               | On |
| Acknowledge           | Steady on    | Off           |    |
| Reset before normal   | Flashing     |               | On |
| Fault cleared         | Steady on    | Off           |    |
| Above fault reappears | Flashing     |               | On |
| Reset after normal    | Off          | Off           |    |
| Circuit test          | Flashing     |               | On |

Client Preferences:

All alarm annunciations will take place on the PLC/SCADA, or DCS.

### 3. FIELD INSTRUMENT DESIGN - TRANSMITTER DESIGN

#### 3.1 Magnetic Flow Meter

3.1.1 Transmitter shall be indicating, electronic type based on law of induction.

3.1.2 Transmitter shall meet the following minimum requirements:



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Witness 2



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Witness 1



Witness 2

Accuracy: 0,5% of span or better  
Repeatability: 0,2% of span  
Output: Linear  
Ambient temperature effect: Not to exceed 0,5% of maximum span per 10°C change.  
Material: - Tube: Stainless Steel  
Liner: Teflon (depending on application)  
Electrode: HastalloyTantalum

### 3.2 Vortex Shedding Meter

3.2.1 Transmitter shall be indicating, electronic type based on the Vortex shedding measuring principle.

3.2.2 Transmitter shall meet the following minimum requirements:

Accuracy: 0,2% of span or better  
Repeatability: 0,2% of span  
Output: Linear  
Ambient temperature effect: Not to exceed 0,5% of maximum span per 10°C change.  
Material: - Tube: Stainless Steel  
Vortex shedder: Stainless Steel

### 3.3 Pressure Transmitter

3.3.1 Transmitter shall be indicating, electronic type based on force balance principle.

3.3.2 Transmitter shall meet the following minimum requirements:

Accuracy: 0,2% of span or better  
Repeatability: 0,1% of span  
Dead band: Not to exceed 0,1% of span  
Ambient temperature effect: Not to exceed 0,5% of maximum span per 10°C change.  
Proof Pressure: 200% of max. process static pressure.  
Mounting: Universal bracket type  
Material: Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.

Adjustment: Independent for span and zero. (Adjustment may be via bus or handheld calibrator)

### 3.4 Temperature Transmitter

Transmitter shall be electronic type for thermocouple connection.

Transmitter shall meet the following minimum requirements:



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Witness 2



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Witness 1



Witness 2

|                             |                                                                                                                                       |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Accuracy:                   | 0, 5% of span or better                                                                                                               |
| Repeatability:              | 0,1% of span                                                                                                                          |
| Dead band:                  | Not to exceed 0,1% of span                                                                                                            |
| Ambient temperature effect: | Not to exceed 0,5% of maximum span per 10°C change                                                                                    |
| Proof Pressure:             | 200% of max. process static pressure                                                                                                  |
| Mounting:                   | Head mounted unless specifically stated otherwise in instrument specification                                                         |
| Material:                   | Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere. |

Adjustment: Independent for span and zero. (Adjustment may be via bus or handheld calibrator)

### 3.5 Capacitance Level Transmitter

Transmitter shall be indicating, two-wire electronic type for rod – or rope-probe connection.

Transmitter shall meet the following minimum requirements:

|                             |                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------|
| Accuracy:                   | 1% of span or better                                                                   |
| Repeatability:              | 0,2% of span                                                                           |
| Dead band:                  | Not to exceed 0,2% of span                                                             |
| Ambient temperature effect: | Not to exceed 0,5% of maximum span per 10°C change.                                    |
| Material:                   | Standard materials that are suitable for process and ambient conditions shall be used. |

Probes: Shall generally be stainless steel /

Teflon coated.

Adjustment: Independent for span and zero.

### 3.6 Ultrasonic Level Transmitter

Ultrasonic level measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echo due to agitators.

Evaluating device shall be indicating, two-wire electronic type. Transmitter shall meet the following minimum requirements:

|                             |                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------|
| Accuracy:                   | 1% of span or better                                                                   |
| Repeatability:              | 0,2% of span                                                                           |
| Dead band:                  | Not to exceed 0,2% of span                                                             |
| Ambient temperature effect: | Not to exceed 0,5% of maximum span per 10°C change.                                    |
| Material:                   | Standard materials that are suitable for process and ambient conditions shall be used. |
| Adjustment:                 | Independent for span and zero. (Adjustment may be via bus or handheld calibrator)      |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### 3.7 Radar Level

Microwave level measurement. Measures the transit time of a radar signal that is reflected from the surface of a liquid.

Transmitter shall meet the following minimum requirements:

Accuracy: 1% of span or better  
Repeatability: 0.2% of span  
Temperature Drift: <100ppm / °K  
Material: wetted parts stainless steel  
Device shall be 2 wire, with a local indication.

### 3.8 Guided Radar Level

Guided radar (TOR) level transmitter. Guided radar is based on time domain reflectometry principle. Low power microwaves are sent along conductors and at the point where the waves meet the product surface the waves are reflected.

Transmitter shall meet the following minimum requirements:

Accuracy: 1% of span or better  
Repeatability: 0.2% of span  
Temperature Drift: <100ppm / °K  
Material: rod or cable – stainless steel

Device shall be 2 wire, with local indication.

### 3.9 Weight Transmitter

Weight transmitters shall be selected in conjunction with load cells, shall have high immunity to plant vibration, allow long distances to load cells and shall be designed to compensate for temperature effects.

Transmitter shall meet the following minimum requirements:

Accuracy: 0,5% of span or better  
Dead band: Not to exceed 0,1% of span  
Ambient temperature effect: Not to exceed 0,5% of maximum span per 10°C change.  
Material: Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.  
Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### 3.10 Open Channel Flow Transmitter

Open Channel Flow ultrasonic measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echoes due to agitator.

Evaluating device shall be indicating, two-wire electronic type. Transmitter shall meet the following minimum requirements:

Accuracy: 1% of span or better

Repeatability: 0,2% of span

Dead band: Not to exceed 0,2% of span

Ambient temperature effect: Not to exceed 0,5% of maximum span per 10°C change.

Material: Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.

Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)

## 4. CONVERTER DESIGN

### 4.1 Electric-Pneumatic Converter (I/P)

Electric to pneumatic converters are intended primarily for use in conjunction with controllers having electrical output or with electrical transmitter where the final control element is actuated from pneumatic actuator or controller.

Pneumatic-electric converter shall be of force balance type and shall convert the direct current input into a standard pneumatic output signal.

Converter shall be provided with a 1:1 relay wherever required in order to provide large volume of air required for rapid operation at long distance.

Transmitter shall meet the following minimum requirements:

Accuracy: 0,5% of span or better

Linearity: 0,1% of span

Hysteresis: 0.2% of span

Ambient temperature effect: Not to exceed 0,5% of maximum

span per 10°C change.

Adjustment: Independent for span and zero.

Mounting: Universal bracket suitable



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Witness 1



Witness 2



Employer



Witness 1



Witness 2



Case:

for horizontal or  
vertical support

Dust-tight for  
general  
application

## 5. PRIMARY ELEMENT DESIGN

### 5.1 Orifice Plate Design

Orifice plates shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, orifice plates shall be designed for flange taps, however, Venacontracta taps may be substituted when designated by good engineering practice.

Concentric type orifices are preferential.

Eccentric or segmented types shall be used for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

The orifice ratio (orifice inside diameter to process pipeline internal diameter) shall, in general, be between 0,3 and 0,7 for metering accuracy.

### 5.2 Annubar Design

Annubar material shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, Annubars shall be designed for single support and on-line vertical, or horizontal taps.

Opposite side support are to be used only in extreme diameter and high flow cases.

On-line steam purge accessories are to be included for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

Flow turndown of 10:1 is acceptable.

Annubar element shall meet the following minimum requirements: Accuracy: 1,0% of actual value

Repeatability: 0,1% of actual value

Mounting: Universal bracket suitable for  
horizontal or vertical support



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Witness 1



Witness 2



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Witness 1



Witness 2

### 5.3 Pressure Elements

Directly connected instruments shall be diaphragm, Borden or bellow type elements depending upon the service requirements.

In general, diaphragm elements shall be used in the range of 0 to 100kPa vacuum or pressure, bellow type element for range of 0 to 1000 kPa and Borden tube element for range higher than 1000 kPa.

Primary element material shall be corrosion resistant to process fluid or chemical seals must be provided for protection.

Primary element material shall provide good creep and fatigue resistance, and low hysteresis.

Proof pressure shall be at least twice the maximum system pressure.

### 5.4 Temperature Elements

The primary elements for temperature services shall consist of resistance thermometers or thermocouples or radiation pyrometers, depending upon the range of measurement.

The following types of elements shall be used for stated ranges:

| Type                              | Temperature Range<br>°C |
|-----------------------------------|-------------------------|
| Pt-Rh (10%) Pt                    | 0 - 1500 Type S         |
| Chromel – Alumel                  | 0 – 1100 type K         |
| Copper resistance Element         | -50 to +100             |
| Platinum resistance Element Pt100 | 0 to +600               |

Whenever specified, duplex thermocouple shall be provided.

Thermocouple/emf calibration shall conform to the International Practical Temperature Scale of 1968 (IPTS).

Gas-tight mineral insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardized thermo-wells shall be used.

Resistance thermometer shall be of three lead connection system to the instrument and shall be gas-tight internal insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardized thermo-wells shall be used.

The resistance/temperature relationship shall conform to British Standard 1904 Table 1, 1979 revision or with DIN 43760.



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Witness 1



Witness 2



Employer



Witness 1



Witness 2

Thermo-wells shall be used for all temperature elements under pressure application. Construction material for thermo-wells shall be suitable stainless steel, unless some other material is required due to process conditions.

## 5.5 Radiation Pyrometers

Radiation pyrometers shall be used when:

- Temperatures are above practical operating range of thermocouple.
- Environment will contaminate or seriously limit the life of thermocouples.
- The target is not easily accessible.
- Where plant requirements make them impractical.

Radiation pyrometers shall be of solid-state circuitry type and shall, for standard application, respond to 98% of target temperature changes within 2 seconds.

The burner flame detector applications, radiation pyrometers shall be designed for use with self-checking flame self-guard controls.

## 5.6 Filled Systems

Filled systems shall not be used unless otherwise specified.

## 6. INDICATOR DESIGN

### 6.1 Flow Indicators

Flow indicator shall be rotameter or differential pressure type.

Rotameters, when used, shall preferably be of metal type with magnetic indicator extension. Glass type rotameters shall be used for purge or auxiliary services.

Differential pressure type, when used, shall in general be of dry type complete with equalizing valve manifold.

Indicators shall have suitable body material and packing of process fluid being monitored.

Scales shall be linear or square root direct reading.

Accuracy shall be 1% of full scale or better and repeatability at least 0,255 of full-scale range.

Proof pressure shall be at least 200% of maximum static process pressure at maximum process fluid temperature.

### 6.2 Pressure Indicators

Pressure gauges shall generally be 150mm diameter. Case and movement – stainless steel.

Scales shall be white with black lettering. Accuracy shall be 1% of full-scale range or better.

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

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Scale ranges shall be selected so that normal process pressure is approximately 50% of full scale.

Rotary geared stainless steel movements shall be used.

Gauges for steam service shall be connected with pigtail siphon. Dampers shall be provided for all pulsating fluids.

Draft gauges shall be diaphragm type or fluid filled manometers.

### 6.3 Temperature Indicators

Temperature indicators shall generally be 100mm dial, bi-metallic or fluid type with thermo-well suitable for application.

Material of construction for thermo-well shall be suitable stainless steel, unless some other material is required due to process conditions.

Fluid filled type indicators, when used, shall be either rigid stem or capillary tubing type. Capillary tubing shall be armour protected.

Stem or bulb shall be suitable stainless steel with welded joints.

Indicator shall be provided with automatic ambient temperature compensation. Accuracy shall be 1% of full-scale range or better.

### 6.4 Level Indicators

6.4.1 Sight level glasses or dial type or float type level indicators shall be used.

6.4.2 Each sight glass shall be complete with a pair of offset valves, valves shall have union level connection, flanged tank connection, vent and drain plugs.

If float type indicators are used, cable must be made of braided stainless steel.

Dial type indicator shall be of differential pressure type having accuracy of 1% of full scale or better.

## 7. SWITCHES AND CONTROLLERS

### 7.1 Mechanical Switches

Pressure, flow level, temperature etc. type switches shall be provided with enclosures of a type to suit individual area environment.

Actuating switches shall be either hermetically sealed mercury type or snap action micro- switches. Contacts shall have a minimum rating of 3A inductive braking at 220V AC.

All switches shall have two parallel contacts normally open/closed and the on-off differential switches shall be



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adjustable. Adjustable range shall be suitable for switch application, actuation set point shall be adjustable over full scale range.

All switches shall have an accuracy of 1% or better of full-scale range.

Level switches shall be in general resonating or displacer type. Standard material shall be suitable for process and ambient conditions. Material of the displacer shall be stainless steel.

Conductivity level switches shall be either single or double type with contacts changeable to minimum/maximum closed safety circuit. Electrodes shall be heavy version, either single or three rod types, material shall be preferable of special steel.

Position switches shall be of inductance or capacitance proximity sensors with single or dual potential free contacts.

## **8. ACTUATORS**

### **8.1 General**

Actuators shall be either pneumatic diaphragm or pneumatic piston type.

All actuators shall have a stall torque rating of at least 150% of maximum required torque for the driven element.

All actuators shall have a minimum repeatability of 0,5% of full travel. Hysteresis effect shall not exceed 1,0% of full-scale travel.

Manual over-ride facilities shall be provided.

A mechanical shaft position indicator shall be standard on all actuators.

Actuators shall have a totally enclosed housing to provide complete protection for all moving, pneumatic, and electronic parts. Construction material shall be suitable for ambient and process conditions.

Unless specified otherwise, actuators be of spring return type for fail-safe operation.

### **8.2 Pneumatic Actuators**

Actuators shall be of diaphragm or cylinder type for either rotary or linear version depending upon specific application and shall be reversible for air-to-open or air-to-close action.

Actuator shall operate on 600 kPa, cylinder shall be able to withstand a line pressure of 1500kPa. Positioner shall operate on 20 to 100 kPa.

Corrosion, endangered parts such as cylinder wall, piston rod, torque plug, etc. shall be manufactured of hard wearing and rustless metal, with high lubricity.



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Actuators shall be provided complete with line filter, lubricator, positioner, manual operating handle and air lock-up system, unless otherwise specified.

For actuator position remote indication, the provision for two limit switches attachment shall be provided.

### 8.3 Electric Actuators

Actuators shall be fitted with a 3 phase 400 squirrel-cage motor.

If two speeds are required a pole-changeable motor may be used.

Output force of the motor shall be transmitted through a stage of spur gears, a spring- balanced worm with axial bearings, a worm wheel, and a clutch stage to the output shaft.

All actuators shall be fitted with a double torque-dependent switch.

For remote position indication of actuators fitted to modulating valves, provision for an analogue 4-20 mA attachment shall be provided. For isolation valves two limit switches shall be provided.

Provision for manual operation shall be made by means of a hand wheel – the mechanically independent hand-wheel shall be engaged by means of a clutch, which also de-clutches the motor drive from the output shaft.

Actuators shall be fitted with a mechanical position indicator.

Technical specifications:

Torque and travel dependent switches:

|                                  |                                                            |
|----------------------------------|------------------------------------------------------------|
| No, NC or change-over:           | 10A at 30V AC, 5A at 250V AC 5A at 30V DC, 0,4V at 250V DC |
| Mechanical lifetime:             | ± 106 cycles Suitable for ambient temperature -20 to +80°C |
| Electronic position indicator:   |                                                            |
| Supply voltage:                  | 15 to 30V smoothed                                         |
| Output:                          | 4-20 mA load R: 500 ohm at 15V, 1250-ohm max. at 30V       |
| Current consumption:             | Max. 40 mA at 20 mA output signal                          |
| Linearity deviation:             | ±1% from 5 to 95% of measuring range                       |
| Suitable for ambient temperature | -25 to +90°C                                               |
| Adjustment:                      | Independent for span or better                             |
| Linearity:                       | 0,1% of span                                               |
| Hysteresis:                      | 0,2% of span                                               |
| Accuracy:                        | 0,5% of span or better                                     |
| Case:                            | Dust-tight for general application                         |



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#### 8.4 Control Valves – General

Control valves for modulation services shall be pneumatically operated.

Flange facing and drilling shall be according to either BS or equivalent DIN standard. Control valves of size 40mm and above shall have flanged end connections.

In general control valves of size 40mm and below shall have screwed connection.

Valve size shall be based on specified allowable pressure drop at 130% of normal process design flow conditions.

Valve top-works shall be sized so that the valve will operate properly when upstream pressure is 10% above maximum inlet pressure and downstream pressure is atmospheric.

Isolating valves and by-pass valves shall in general be provided for each control valve application. Isolating valves shall be of line size whereas by-pass valves shall be of control valve size.

Seals and liner material used for valves in boiler gas lines shall be made of VITON. Nylon shall not be used unless otherwise specified.

Close attention shall be given to the selection of valve body, line and diaphragm material depending upon specific application; however, Engineer approval is required prior to order.

#### 8.5 Diaphragm Valves

Diaphragm valves shall be used where process control quality requirements are comparatively poor, and a low pressure drop across the valve is required or where the valve function is restricted to on-off control

Diaphragm valves shall be used for aggressive fluids such as weak sulphuric acid, corrosive, slurry, and sludge which contain solids in suspension.

For application with high control frequency another valve type shall be considered. Material construction:

Body: Cast Iron

Liner: Hard rubber, soft rubber, Butyl

Diaphragm: Depending on application.

#### 8.6 Globe Valves

Globe valves shall be used in the majority for conventional control application.

For water, steam, gas and air control applications, a cast steel valve body with stainless steel trim shall be provided.

In case of special treated water, selection of stainless-steel body may become necessary.

For oxygen control application, a bronze valve body with monel-metal trim and a PTFE Chevron packing shall be



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provided.

Trim material shall normally be of 316 stainless steel, for special applications stellite shall be used.

Extended bonnets and graphite laminate/filament packing shall be used for operating temperature higher than 200°C up to 530°C.

## 8.7 Butterfly Valves

Butterfly valves may be used for modulating service but shall not be used for shut-off service if the maximum differential pressure across the valve exceed 500 kPa.

Butterfly valves shall be used for high control performance and where low process pressure loss with high recovery is required.

For water, gas and air application, a cast steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for high temperatures. In case of special treated water, selection of a stainless-steel body may become necessary.

For acid application polypropylene valves shall be provided.

Close attention shall be paid to the selection of valve body, disk and packing material depending upon specific application; however, Engineer approval is required prior to order.

## 8.8 Ball Valves

Ball valves shall be used for modulating and shut-off service where high control performance with low process loss and high recovery as well as tight shut-off function is required.

For water, gas and air application, a stainless-steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for higher temperatures.

## 9. ANALYTICAL INSTRUMENTS

### 9.1 General

Instruments measuring pH-value, Dissolved Oxygen, Conductivity, Concentration or other properties of process streams shall consist of a suitable design primary element to convert or transform the measured variable into an electrical signal which shall be fed to a control system.

Analyzer shall be capable of operating under the ambient conditions prevalent in the specific plant area and to maintain calibration within 0,5% during a 24-hour period while subject to temperature variations between 10°C and 50°C.

Analysis time shall not exceed 30 seconds.



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Reproducibility of analyzers shall be 1% of span or better and sensitivity shall be 0,5% of full span.

For calibration purposes, analyzers shall be provided with one year supply of a certified calibration sample as well as calibration curves.

All necessary accessories including nozzles, valves and fittings shall be provided. For high temperature applications, sample coolers shall be provided. Sampling accessories shall be of material suitable for each specific application.

## 9.2 PH Measurement

For pH-measurement, reference electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly onto the outer end of the element ensuring first class electrical performance of the electrode.

Measuring pH-electrode shall be of toughened all-purpose glass type giving accurate Ph reading with long electrode life.

In applications where variations in sample temperature may occur, automatic temperature compensation device shall be provided.

The reference and glass electrode including the automatic temperature compensator shall be housed in a compact sensor holder assembly provided with terminal block, cable glands, silica-gel desiccator and screened top cap to prevent against spurious pick-up.

Electrodes assembly materials shall be of glass couples polypropylene and the assembly shall be provided with either flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

pH-transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy: 0,5% of span or better

Measuring range: 0-14 pH

Temperature Compensation: Glass electrode 0° to 130°C

Cycle: max. 1,5 seconds

Output: Preferable 4 to 20 mA DC

Relay Output: Alarm contact 220 V AC 5A NC

Mounting: Universal type bracket

## 9.3 Conductivity Measurement

Cell electrode material shall be carbide lined high grade steel or platinum black coated nickel and the cell range



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shall be selected to suit the required measurement.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be either of flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

Conductivity transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements.

Accuracy: 2% of span or better

Measuring range: 0,1 to 100  $\mu$ S/cm depending on used cell type

Reproducibility: 1% within range or better

Temperature Compensation: Semiconductor 0° to 130°C

Cycle: max. 1,5 seconds

Output: Preferable 4 to 20 mA DC

Relay Output: Alarm contact 220 V AC 5A NC

Mounting: Universal type bracket

#### 9.4 Oxygen in Combustion Measurement

Cell electrode material shall be of Zirconia.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be direct insertion type, complete with all associated accessories and mounting brackets.

Oxygen analyzer transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirement:

Accuracy: 1,0% of span or better

Measuring range: 0 to 5, 0 to 10 or 0 to 20 vol % O<sub>2</sub>

Reproducibility: 1% within range or better

Temperature Compensation: 0° to 1400°C

Response rate: 90% response within 5 sec when gas introduced from calibration gas inlet

Warm up time: max. 15 minutes

Output: Preferable 4 to 20 mA DC

Relay Output: Alarm contact 220 V AC 5A NC

Mounting: Universal type bracket

Calibration: One-touch calibration using calibrated memory

#### 9.5 Dissolved Oxygen Measurement

The measuring sensor shall be of the Luminescent type – LDO technology.



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The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion. The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application to allow easy access for cleaning purposes.

The DO transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy: 0,2% of span or better  
Measuring range: 0-20.0 ppm or 0-20 mg/L  
Temperature Range 0 to 50°C  
Response time: 90% in less than 40 sec.  
Power Supply: 220 V AC  
Output: 4 to 20 mA DC  
Mounting: Universal type bracket

## 9.6 Turbidity Measurement

The measuring sensor shall be of the self-cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance

The Turbidity transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy: 0.001 NTU  
Measuring range: 0.001 – 4000 NTU  
Temperature Range 0 to 50°C  
Power Supply: 220 V AC  
Output: 4 to 20 mA DC  
Mounting: Universal type bracket

## 9.7 Suspended Solids Measurement

The measuring sensor shall be of the self-cleaning type with wiper blade



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The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Suspended Solids transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy: < 5% of reading  
Measuring range: 0.001 – 50 mg/l  
Temperature Range 0 to 50°C  
Power Supply: 220 V AC  
Output: 4 to 20 mA DC  
Mounting: Universal type bracket

### 9.8 Tank or Hopper Mass Measurement

If mass content measurement of a vessel is required, the vessel shall be supported on load cells.

The mechanical design shall make provision for load cell protection against overload, shock load and plant vibration. It shall also take into consideration the prevention of excessive shear loads being transmitted to the load cell without affecting the accuracy of the scale.

Jacking facilities shall be provided to enable the load cell to be removed without taking the vessel out of service.

Copper braiding shall be connected across load cells to protect them against welding currents.

Continuous weight monitoring shall be achieved by the load cells weight detectors, weight transmitters and suitable indicators. An electrical signal, preferable 4 to 20 mA, shall be provided to be fed to a control system.

Load cells shall be of robust hermetically sealed stainless-steel construction and shall meet the following minimum requirements:

Temperature Compensation: 0 to 55°C  
Temperature Effect: Not to exceed 0,5% of maximum span per 10°C change  
Accuracy: 0,5% or better  
Overload: 200% of nominal load  
Rated Output: 1mV/V



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Load cell cable joints are to be soldered according to manufacturer's instruction.

## 10. INSTRUMENT PANELS AND CABINETS

### 10.1 Construction

Panels shall be free standing type and shall be fabricated from cold rolled sheet steel of thickness not less than 2mm with welded construction throughout. All welds shall be ground smooth, all corners to be ground and all weld spatters shall be cleaned.

Surface of panels shall be painted and free from all marks and defects.

Mounting angle, flush with bottom of panel, shall be provided. All panels shall be supported on suitable sized vibration isolators, designed for bolting to panel frame and flooring.

Accessories such as swing rack mounting frames, circuit breaker panels and covers, base gland plates, etc., shall be standardized.

Front doors shall be fitted with suitable armoured glass cut-out and rubber gasket and shall be hinged door lockable. Rear doors shall be of solid construction and lockable.

All instrument cut-outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut-outs shall be made, and suitable blanks shall be provided. Blanks shall be painted with same colour as panel and a minimum of four anchors shall be used to attach them to panel board.

Instruments mounted on panels shall be spaced to provide access for adjustment and removal of equipment.

Removable eye bolt lifting lugs shall be furnished and installed on all panels.

### 10.2 Field Junction Boxes

Boxes shall be constructed of 304SS and painted with hinged and lockable door. Mounting plate and bottom gland plate suitable for electric and pneumatic process connection shall be standardized.

All instrument cut outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut outs shall be made and suitable blanks shall be provided.

Instruments mounted on boxes shall be spaced to provide access for adjustments and removal of equipment.

The degree of protection shall comply with IP 65. Construction material shall be suitable to resist the conditions prevalent in the specific plant area.

Field boxes are to be fitted with knife type termination, indicating fuse holders are to be used where power is supplied to solenoids or any other secondary

Field instrument.

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All cables should be properly glanded and all cores will be terminated PLC/DCS connections are to be terminated at the left and field connections terminated at right.

All terminals to display an identification number according to the numbering standard as applied.

## **PSCI - PARTICULAR SPECIFICATIONS FOR CONTROL AND INSTRUMENTATION REFURBISHMENT AND UPGRADE WORKS**

### **SPECIFICATION: C&I 0001 – OPERATION AND CONTROL**

#### **1. Introduction**

C&I 001 specifies the standard requirements for control systems

#### **2. Scope**

The detail of the work for which the Contractor is responsible is specified elsewhere, including hardware and software design details.

The design of the control system, including drawings, control narrative, functional specification, control panel layouts, circuit diagrams and protection systems shall be submitted to the Engineer for approval.

#### **3. Normative References**

The following documents form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (C&I 001).
- b) The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

#### **4. Equipment Eligibility**

Equipment provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

#### **5. Requirements for all Control Systems**

Control Systems shall incorporate the following:

- Emergency stop stations shall be provided near to each motor driven unit.
- Manual operation of all items of equipment shall be provided in addition to any automatic and/or motorised operation which is specified.
- Equipment which is controlled automatically shall be provided with protections against damage during start



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up.

- Shut down shall be engineered to occur safely and without damage. This applies to normal conditions, emergency conditions and also to power failure.

Protection systems which prevent damage to equipment shall be active during manual operation of equipment (unless this is not feasible or sensible).

Setpoints for equipment and process parameters which are required for the operation of control systems shall be obtained once the equipment is operational and these shall be provided in the Manual.

## 6. Control Panels

Each motor starter cubicle shall include the following equipment:

- Circuit breaker (complete with auxiliary contacts for control circuits).
- Contactor.
- Overload relay with manual reset.
- Ammeter (CT based, if above 40A).
- Starter alive indicating light (Red).
- Motor running indicating light (Green).
- Running hour meter.
- Selector switch.
- Stop push button.
- Start push button.

## 7. Systems with PLC / SCADA Control

### 7.1 Design

Control systems utilising PLC/SCADA systems shall be configured so that the installation will be able to operate under PLC control following a failure of the SCADA system.

### 7.2 Mimics

- Mimic screens provided for SCADA systems shall include the following:
- Overview; including the process flow diagram and indicating all electronically monitored parameters which are not included in a sub-system.
- Overview of each plant grouping.
- Individual unit (Centrifuge, compressor, pumpset, etc.).
- Equipment sequence selection.
- Equipment start interlocks.
- For each motor larger than 55 kW, motor status and, where applicable, motor protection relay diagnostic.
- Electrical reticulation schematic.
- Hardware diagnostic.
- Alarms.



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- Set points for alarm, trip and control loop functions (including password protected alteration facility).
- Event log.
- Record of equipment and process parameters at instant of equipment trip and station trip.
- Communication status of control system hardware.
- SCADA security system current settings, including personnel names.
- Ancillary equipment status, e.g. security, fire detection, UPS.
- Printing.

Any of the above mimic screens which are not applicable to a particular Contract may be excluded.

### 7.3 Trending

Trend screens of monitored parameters shall be provided for 3 hours, for 7 days and for 3 months (unless the nature of the parameter demands different scales).

### 7.4 Printers

One colour printer for graphs, mimics, etc. and one printer for events and alarms shall be provided.

### 7.5 Alarms

The control system shall provide an alarm if an instruction to an item of equipment to start or stop does not cause that item to start or stop.

Alarm conditions which lead to an equipment trip shall be logged. The condition which caused the trip shall be described with respect to the:

- Item of equipment.
- Trip setpoint reached.
- Description of parameter, i.e. flow, temperature, etc.
- Time of event.

Subsequent alarms which occur as a result of the tripping action shall be logged as subordinate alarms.

### 7.6 Digital Indication of Parameters

Three significant places shall be used for representation of values on SCADA systems.

## 8. Spares

The spares which are to be provided are specified elsewhere.

## 9. Testing Requirements

### 9.1 Factory Testing

The Contractor shall make all arrangements and carry all costs for the Engineer to attend a factory inspect test in the workshop.

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## 9.2 Site Testing

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works. The Contractor shall submit a schedule of all control functions to be checked on Site during testing and commissioning. This shall be submitted to the Engineer for approval. The format shall be as follows, or similar:

| COMMISSIONING - CONTROL SYSTEM TESTS |               |             |                                   |                                            |
|--------------------------------------|---------------|-------------|-----------------------------------|--------------------------------------------|
| Date                                 | Test Function | Test Method | Result (e.g. SCADA message, etc.) | Proposed Corrective Action (if applicable) |
|                                      |               |             |                                   |                                            |
|                                      |               |             |                                   |                                            |
|                                      |               |             |                                   |                                            |
|                                      |               |             |                                   |                                            |
|                                      |               |             |                                   |                                            |

Although the engineer shall still review and approve construction drawings by the contractor prior to procurement and installation, it remains the contractor's responsibility to design and engineer the control and instrumentation equipment and the installation in accordance with the Specification and good engineering practice.

## 10. Detailed Scope of Work

All the PLCs currently installed are in good working condition except for the fact that the CPUs (L32) are now obsolete. These PLC systems shall be upgraded to the latest version as per the manufacturer's recommendation. The HMI shall also be upgraded to the latest version. All the instruments installed shall be tested and recalibrated to ensure correct functionality. An OEM certificate will be required for each instrument to confirm correct operation and functionality. The SCADA system shall be upgraded to the latest software version, and provisions shall be made for the improvement of the graphic pages' looks and feel, alarms and trends configuration.

### 11.1 PLC, SCADA and HMI System

The current Programmable Logic Controllers (PLCs) installed are the Allen Bradley ControlLogix L32E, and the HMIs are PanelView Plus 700. Both the PLCs and HMIs shall be replaced with the latest version from the same supplier or similar products. The contractor shall provide a permanent license for programming the PLCs and HMIs. The PLCs, SCADA and HMIs shall be programmed according to an approved control philosophy. The control shall develop a final control philosophy document for each PLC system that will be approved by the client before proceeding with the PLC programming.

Minimum Specification for:

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### Programmable Logic Controller (PLC)

#### **A. Features**

- Communication service: Ethernet IP
- Controller tasks Continuous: 32 tasks
- Controller tasks Periodic: 1000programs/ tasks
- Controller tasks Event: All event triggers
- Built-in communications ports: USB port x1, Ethernet port x2.
- USB port communication: USB 2.0, type B, 12Mbps full speed.
- Ethernet performance: 10 Mbps, 100 Mbps, 1 Gbps (Full-duplex only)
- I/O Capacity (Class 0/1): 2000 without CIP security, 40000 with integrity, 20000 with integrity and confidentiality.
- Message rate capacity 128000 without CIP security, 1500 with integrity, 900 with integrity and confidentiality.
- Ethernet IP network topology supported: DLR, Star, Linear.
- Ethernet/IP nodes supported max: 120.
- Socket Interface Supported max: 32.
- The number of axes supported: 256.
- Programming languages IEC61131: Ladder Diagram (LD), Structured text (ST), Function Block Diagram (FBD), Sequential Function Chart (SFC).

#### **B. Technical Specifications**

- User Memory: 5MB.
- Optional non Volatile memory: 1GB, 2GB, 8GB, 32 GB.
- Local I/O modules, max: 31.
- The number of power cycles: 80000.
- Power Voltage Range: 0...32V DC, 0...240V AC, 47...63HZ.
- Power Current , max: 10 mA (DC), 25mA (AC).
- Power Current rating, max: 10A (AC or DC).
- Power dissipation: 8.5W.
- Thermal dissipation: 29BTU/hr.
- Weight, approx.: 0,768Kg
- Dimensions (HxWxD), approx.: 143.97x98.10x136.81mm.
- Location: Din rail mount (horizontal mount only).
- Wire Size: 0.5...1.5mm<sup>2</sup>.

#### **C. Environmental Specifications**

- Temperature, operating: 0 of <TA< +60 oC
- Temperature nonoperating: -40 oC ... +85 oC
- Temperature, surrounding air, max: 60 C



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- Relative humidity: 5...95%.
- Vibration: 5g @ 10...5000 Hz.
- Shock, operating: 30g.
- Shock nonoperating: 50g.
- Emissions: IEC 61000-6-4.
- Certification: EN 61326-1, EN 61131-2, EN 61000-6-2, EN 61000-6-4, EN 61131-2.

#### Human Machine Interface (HMI)

- Operator output: Touch or Touch with keypad
- Conformal coated: yes
- Display Type: TFT colour
- Display resolution: 640x480 VGA, 18bit color graphics
- Aspect ratio: 4:3
- Backlight life: White light-emitting diode, solid state.
- Battery life: 4 years min at 25 C
- Memory system: 512 MB and 512 MB (Series A), 4 GB and 19.87 (Series B),
- Memory User: 80MB (Series A) and 2GB (Series B)
- SD Card slot: one SD Card for external storage
- USB ports: 2x USB ports
- Ethernet ports: two 10/100 Base-T that support Ring, Linear or star network topology.
- Software: FactoryTalk View Studio
- Input Voltage: 24V DC
- Power consumption: 50W max

### **11.2 Pump Station PLC System**

Pump Stations 1,2 & 3 PLC systems are all similar, although PS1 has more pumps. The PLCs and HMIs shall be replaced with the latest model from the same supplier or similar products that meet the minimum requirements as per the PLC specification. The instrumentations in the pump station shall be connected to the PLC controlling that specific pump. The following common service equipment shall be connected to the main PLC:

- Cooling water Pumps
- Module 2 Reservoir level (for PS1)
- Combined Reservoir level (for PS1)
- Contact tanks connection valve (for PS1)
- Pump Station outlet Flow meters
- Pump Station delivery Pressure transmitter
- Pump Station delivery Pressure Switch

### **11.3 Telemetry System**

The sites are currently using SPECTRUM telemetry system. The Current telemetry system is to be upgraded from analogue to digital radio from the same supplier or alternative product that will allow for a seamless upgrade. An



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option to communicate via GSM should be added to the system; this shall also be used to accommodate areas of poor RF coverage.

## 11. Design Approach

The current control and instrumentation design basis shall be used as a baseline for this contract. However, the engineer may make changes to that design where errors or improvements are found. The design approach will broadly (but not exclusively) follow the following standards and guidelines:

- The South African National Standard for the Wiring of Premises Part 1 and Part 2 (SANS 10142-1:2017 and 10142-2:2017),
- The South African National Standard for the classification of hazardous locations and the selection of equipment for use in such locations (SANS 10108:2017),
- Instrumentation Symbols and Identification (ISA-5.1)
- Instrument Loop Diagrams (ISA-5.4)
- Human Machine Interfaces for Process Automation Systems (ISA-101.01)
- The standard for programmable controllers (IEC 61131)

It should be noted that the above standards are not exhaustive but form the broad design approach standards basis that will underpin the project. Specific standards will be covered under each application area where required.

The contractor shall update and submit the following design documents or drawings for approval:

### For Control System Design

- General Arrangement Drawings
- I/O list
- Schematics Drawings
- Control System Network Architecture
- Telemetry System Network Architecture
- Telemetry Wiring drawings
- Instrumentation Loop Drawings
- Cable Block Diagrams
- Instrumentation Datasheets
- Instrumentation Index
- Instrumentation hook ups drawings
- Updated Control Philosophy
- Functional Design Specification

## 12. Testing and Commissioning

The contractor shall establish a QA system for the testing and commissioning of the Control System. Documentation is to be provided with sufficient detail to enable the complete commissioning of the systems. The purpose of this document is to ensure that the commissioning of the systems is performed according to acceptable historic standards before handing over for operation with enough detail to enable the complete commissioning. The objective is that:



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

**PARTICULAR SPECIFICATION**

**PBA : BUILDING WORK**  
of the control systems are specified in enough

1. Tests required for the commissioning detail,
2. Resources are allocated to perform the tests,
3. Accountability for the performance of the tests rests with the resource allocated,
4. Documentation is available which indicates:
  - a. Test results
  - b. Equipment tested
  - c. The person who performed the test
  - d. The date on which the tests were performed.

**13. Training**

The contractor shall be responsible for the training of three of the Employer's staff for each plant. The training is to take place at Ebenezer and Olifantspoort plants. The Employer will provide suitable facilities for the training. The following training is required by the Employer and shall be included in the tender price.

**14.1 PLC System**

Two courses shall be given, these being:

- a) An introductory course for the PLC system. This course shall cover all the features of the software and shall enable the Employer's staff to do fault finding on the system using the status from the PLC.
- b) Plant operation Training. This training shall cover how to operate various plants from the SCADA or HMI system.
- c) A follow-up course shall be offered three months after the introductory course; this course shall clarify any uncertainties or queries that the Employer's staff may have

**14.2 Operation and maintenance**

The contractor shall train the Employer's staff to be proficient in:

- a) Fault finding.

**1. SCOPE**

This section specifies the general requirements for the construction of conventional buildings.

**2. SUPPORTING SPECIFICATIONS**

Reference is made to the latest issues of the following standards: SANS 22

|      |     |                                               |
|------|-----|-----------------------------------------------|
|      |     | Glazed ceramic wall tiles and fittings        |
| SANS | 28  | Metal ties for cavity walls                   |
| SANS | 38  | Metallic naphthenates for timber preservation |
| SANS | 227 | Burnt clay masonry units                      |
| SANS | 248 | Bituminous damp-proof courses                 |
| SANS | 266 | Gypsum plasterboard                           |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



|      |       |                                                                  |
|------|-------|------------------------------------------------------------------|
| SANS | 497   | Glazed ceramic sanitaryware                                      |
| SANS | 523   | Limes for use in building                                        |
| SANS | 542   | Concrete roofing tiles                                           |
| SABS | 545   | Wooden doors                                                     |
| SANS | 581   | Semi-flexible vinyl floor tiles                                  |
| SANS | 632   | Clay roofing tiles                                               |
| SANS | 727   | Windows and doors made from rolled mild steel sections           |
| SANS | 952   | Polyolefin film for damp-proofing and waterproofing in buildings |
| SANS | 1024  | Welded steel fabric for concrete reinforcement                   |
| SANS | 1090  | Fine aggregates for plaster and mortar                           |
| SANS | 1129  | Steel door frames                                                |
| SANS | 1215  | Concrete masonry units                                           |
| SANS | 50197 | Cement                                                           |
| BS   | 3148  | Methods of test for water for making concrete.                   |

### 3. GENERAL

All building work shall be carried out in accordance with the National Building Regulations and Building Standards Act (Act 103 of 1977), as amended, and these specifications.

Reference to specifications and codes of practice of the South African Bureau of Standards shall be taken to be references to the latest edition of such specifications and codes of practice as amended. Wherever possible the SANS (SABS) mark shall appear on all articles, materials or items where it is required to comply with such SANS specification.

### 4. COMMERCIAL PRODUCTS

In all instances where the Contractor handles, stores, uses, applies or fixes commercial products the work shall be carried out in strict accordance with the manufacturer's instructions and specifications.

### 5. SAMPLES

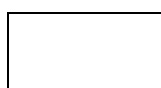
The contractor shall furnish such samples as called for by the Engineer. Materials and/or workmanship that does not correspond with the approved samples may be rejected by the Engineer and shall be removed from the works at the Contractor's expense.

### 6. MATERIALS

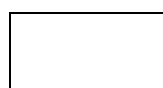
#### 6.1 Lime

Lime shall be burnt plaster lime complying with the requirements of SANS 523.

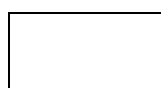
#### 6.2 Cement



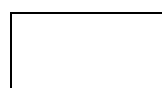
Contractor



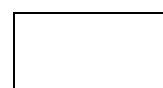
Witness 1



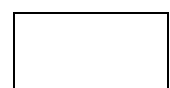
Witness 2



Employer



Witness 1



Witness 2

Cement for masonry work shall be ordinary Portland Cement complying with the requirements of SANS 50197-1. No cement which is older than eight weeks or which contains lumps from absorbed moisture may be used.

### **6.3 Sand**

Sand for mortar and plaster shall comply with the requirements of specification SANS 1090.

### **6.4 Water**

Water shall be clean and free from injurious amounts of acids, alkalis, sugar and other organic substances and shall be in accordance with the requirements of BS 3148.

### **6.5 Burnt Clay Masonry Units**

Bricks, blocks and other masonry units shall be good quality and comply with the requirements of and be classified according to SANS 227.

Unless otherwise specified in the Contract, the following classes of bricks shall be used : For all

|                                                    |                           |
|----------------------------------------------------|---------------------------|
| external brickwork where specifically called for : | Facings.                  |
| For all plastered brickwork :                      | General purpose or stock. |
| For all other brickwork :                          | Engineering.              |

All types and classes of bricks shall be subject to the approval of the Engineer at all times.

Care shall be taken during loading, transporting, off-loading and handling on the site to prevent damage to bricks. Facings shall in particular be carefully placed in layers separated by straw or other suitable material until installed.

### **6.6 Air bricks**

Air bricks shall be of the terracotta type complete with insect gauze.

### **6.7 Concrete Masonry units**

Manufactured concrete masonry units shall comply with the requirements of SANS 1215 and shall be solid unless otherwise specified in the Contract.

### **6.8 Lintels**

Unless otherwise specified in the Contract, lintels shall be of the pre-stressed hollow clay tile, or pre-stressed concrete type subject to the approval of the Engineer, and suitably designed for the loads and spans for which they will be required to carry.

### **6.9 Wall Ties**

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Contractor

Witness 1

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Employer

Witness 1

Witness 2

Wall ties for cavity walls shall be of the vertical twist type coated with zinc complying with the requirements of SANS 28.

#### **6.10 Brickwork Reinforcement**

Reinforcement used between layers of brickwork shall be manufactured from 3,15mm diameter hard-drawn high tensile mild steel wire with 2,8mm diameter cross wires spaced at centres not exceeding 300mm welded to the main wires, all according to SANS 1024.

#### **6.11 Damp proof course**

Unless otherwise specified in the Contract, damp proof courses shall be Polyolefin film to SANS 952, of 250 micron in dry areas and 375 micron in coastal and other wet areas.

#### **6.12 Quarry Tiles**

Quarry tiles shall be of approved quality, well burnt, with sharp arrises, uniform thickness and colour and free of warps. Tiles shall be handled and packed and care taken during loading, transporting, offloading and handling on site to prevent damage to the tiles.

#### **6.13 Ceramic Tiles**

Glazed ceramic wall tiles shall comply with the requirements of SANS 22 and shall be of the size and pattern specified.

#### **6.14 Steel Windows and Doors**

Steel windows and doors shall comply with the requirements of SANS 727 and shall be hot dipped galvanized.

#### **6.15 Pressed Steel Door Frames**

Pressed steel door frames shall comply with the requirements of SANS 1129 and shall be hot dipped galvanized.

#### **6.16 Plasterboard**

Gypsum plasterboard shall comply with the requirements of SANS 266.

#### **6.17 Cove Cornices to Ceilings**

Cove cornices shall be either gypsum plasterboard cornices complying with the requirements of SANS 266 or timber cornices of 32mm SA pine, as specified.

#### **6.18 Hardwall Gypsum Plaster**

This shall be a retarded semi-hydrate hardwall gypsum plaster of finishing quality or a retarded semi-hydrate neat finishing gypsum plaster.

#### **6.19 Plasterboard Bonding Plaster**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

This shall be retarded semi-hydrate wood fibre plasterboard bonding gypsum plaster.

## **6.20 Structural Timber**

Unless otherwise specified, structural timber shall be SA pine complying with the requirements of SANS 1783, and unless otherwise specified or shown on the drawings, shall be Grade 4.

Roof branding and battens and other structural timbers not less than 50mm or more than 65mm in width and not less than 38mm or more than 50mm thickness shall be of SA pine complying with the requirements of SANS 1783-4.

All structural timber shall bear the full standardisation mark of the South African Bureau of Standards (SABS).

## **6.21 Timber for Joinery**

Timber for joinery shall be either softwood complying with the requirements of SANS 1783 or hardwood complying with the requirements of SANS 1099, as specified.

Timber for joinery shall be Clear Grade, unless otherwise specified.

## **6.22 Treatment of Timber**

All timber shall be given a preservative treatment suitable for the duty for which the timber is intended in accordance with the SANS Code of Practice 10005 and no untreated timber shall be used. The preservative treatment shall not impair the final finish specified.

## **6.23 Structural laminated Timber**

Glued laminated timber shall comply with the requirements of SANS 1460 and shall be marked as laid down in the specification and shall also bear the standardisation mark of the South African Bureau of Standards (SABS). Finger joints shall comply with the requirements of SANS 10096.

## **6.24 Galvanised Steel Roof Sheets**

### **6.25**

Galvanised steel roof sheets shall be of the profile specified or shown on the drawings, of minimum 0,6mm thick mild steel and shall be fully galvanised to the requirements of SANS 4998 or SANS 3575, as applicable, for a Class Z275 coating unless another class of coating is specified.

## **6.26 Metal Ridging for Steel Covered Roofs**

Galvanised steel ridging for hips and ridges shall be of minimum 0,6mm thick mild steel and shall be fully galvanised to the requirements of SANS 4998 or SANS 3575, as applicable, for a Class Z275 coating unless another class of coating is specified.

## **6.27 Fibre Cement Roof Sheets**

Fibre cement roof sheets shall be of the profile specified or shown on the drawings and shall comply with the requirements of SANS 685 and SANS 9933. Sheets shall not be less than 6mm thickness.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### 6.28 Fibre Cement Ridging

Fibre cement ridging, (adjustable and non-adjustable) shall be of the same manufacture and profile as the roofing sheets, shall be not less than 6mm thickness and shall comply with the requirements of SANS 685 and SANS 9933. End joints shall overlap and the width of the wings shall not be less than 300mm measured from the centre of the roll.

### 6.29 Fascias and Barge Boards

Unless otherwise specified, fascias and barge boards shall of fibre cement manufacture and shall comply with the requirements of SANS 685.

### 6.30 Concrete Roofing Tiles

Concrete roofing tiles shall be of the colour and profile specified and shall comply with the requirements of SANS 542.

### 6.31 Framed and Ledged Batten Doors

Framed and ledged batten (FLB) wooded doors shall comply with the requirements of SANS 545. In the case of softwood doors the timber shall comply with SANS 1783 and for hardwood doors with SANS 1099. Timber shall be of Clear Grade without any laminations.

### 6.32 Flush Doors

Flush doors shall be solid laminated, chip core or hollow-core as specified and shall comply with the requirements of SANS 545.

Unless otherwise specified veneers shall be rotary cut and shall be of the timber specified.

### 6.33 Ironmongery

All ironmongery shall be of best quality and shall be approved by the Engineer before fixing. Screws for fixing shall be of similar metal to the articles fixed.

Locks for doors shall comply with the requirements of SANS 4 and shall be supplied with two keys each. No key shall operate a second lock. On no account shall the keys be delivered with the locks or doors to the building site. Failure to comply with these requirements shall entail the provision and fitting of new locks and keys.

Unless otherwise specified, interior land exterior doors shall be fitted with two and four lever heavy-duty mortice locks respectively and shall be master-keyed.

### 6.34 Paints

All paints shall comply with the relevant SANS requirements and shall bear the SABS mark on the container or packaging.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

All paint materials shall be brought onto site in unopened containers and no adulteration shall be allowed.

Paints shall be suitable for application on the surfaces on which they are to be applied and those for external use shall be suitable for exterior use and of exterior quality.

Undercoats shall be supplied by the manufacturer of the paint being used for the finishing coats.

The various primers, undercoats and paints shall comply with the requirements of the following specifications, as applicable :

(a) Primers

|           |          |
|-----------|----------|
| For wood  | SANS 678 |
| For metal | SANS     |

(b) Undercoats

|                  |          |
|------------------|----------|
| For all surfaces | SANS 681 |
|------------------|----------|

(c) Paints

|                                |          |
|--------------------------------|----------|
| Flat and eggshell              | SANS 515 |
| High gloss enamel paint        | SANS 630 |
| Oil gloss                      | SANS 631 |
| Emulsion (interior)            | SANS 633 |
| Emulsion (exterior)            | SANS 634 |
| Aluminium paint                | SANS 682 |
| Epoxy coal tar                 | SANS 801 |
| Varnish for interior use       | SANS 887 |
| Red oxide zinc chromate primer | SANS 909 |
| Calcium plumbate primer        | SANS 912 |
| Roof paint                     | SANS 940 |

## 7. PLANT

The Contractor shall provide and have at his disposal all normal plant necessary for the proper and neat completion and finishing of all facets of the building work. This shall include scaffolding and other means of accessing the work.

## 8. EARTHWORKS

### 8.1 Clearing Site

The whole area of the ground to be built upon shall be cleared to a distance of at least 1 m beyond the perimeter of the structure of building(s) and/or extent of steps, pavings, etc. This operation shall be deemed to include the digging up and removal of rubbish, debris, vegetation, hedges, shrubs and small trees (up to 200 mm girth), bush, etc. as well as the digging up of top soil and examining for and removal of all dead roots and other vegetable



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

matter likely to provide food for termites.

## **8.2 Excavations**

### **8.2.1 Notification by contractors and excavators**

In terms of the Factories, Machinery and Building Work Act, 1941, as amended through Act 6 of 1983, every Contractor shall immediately furnish the Engineer with the following information in writing:

- (a) Name of Builder (Contractor) or Excavator (Earthworks Contractor/Subcontractor).
- (b) Name and style under which his business is carried out.
- (c) His business address.
- (d) The premises or place where building or excavations are to be commenced as well as the expected starting date.

### **8.2.2 Excavations for basements, foundations and floors:**

Excavations for the formation of basements, vaults and the like, shall be of such area and depths shown on drawings, together with any such additional prescribed excavations that may be required for working space (see 8.2.4 below for scope of working space measured).

Trenches and holes for foundations shall be excavated to the dimensions and depths shown on drawings or to such other depths as may be directed by the Engineer to ensure a good foundation.

Bottoms of trenches and holes shall be level, with sides trimmed vertical for the full width from top to bottom. The bottoms of trenches shall be stepped as shown but if the steps are not shown on drawings or are not otherwise directed on site, the stepping shall be of at least the thickness specified for the concrete footings but shall be adjusted downwards to conform with an exact number of brick courses where necessary. Any excavations taken out too deep shall be made up to correct levels with Class A concrete, at the Contractor's expense. Back filling and ramming is not acceptable.

The ground under solid floors shall be excavated where necessary and levelled in readiness for the laying of the surface beds. The ground under suspended wooden floors shall be excavated where necessary so that in no case will the finished ground level be less than 0,75 m below floor joists where the ground is to be treated against termites, or less than 0,3 m below floor joists where the ground is not to be so treated.

### **8.2.3 Excavations to reduce levels**

The ground outside buildings shown to be reduced in levels, shall be excavated and levelled or graded to the falls as shown on the drawing(s).

Sloping banks shall be of such gradient as will maintain the stability of the ground above, and shall be neatly trimmed. For purposes of landscaping and the planting of grass the gradient must not exceed 30° to the horizontal.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



## 8.2.4 Excavations for working space

Working space for formwork to sides of all concrete, except columns, will be measured only where the concrete face is less than 750 mm from the face of the measured excavation.

Working space for formwork to sides of columns will be measured for the width of the column face only where both:

- a) the top of the column base is more than 1,5 m below the commencing level of the excavation, and
- b) the column face is less than 500 mm from the face of the measured excavation.

No claim will be considered for any working space for formwork to concrete other than as described above nor for working space beyond the sides of trench excavations for the building of brick or block walls.

Descriptions of excavations for working space shall be deemed to include any additional risk of collapse so incurred and the backfilling and compacting of the excavated material as described.

## 8.2.5 Definitions

**Earth** shall mean ground that can be removed by hand tools and shall include loose gravel, clay, made up ground, loose or soft shale, loose ouklip and any loose boulders less than 75mm in diameter.

**Soft rock** shall mean rock that can be loosened by hand, pick or crowbar and includes hard shale, compact ouklip, stone of a similar hardness and boulders from 75 mm diameter up to 0,03 cubic metres in volume.

**Hard rock** shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness and boulders from over 0,03 cubic metres in volume.

## 8.2.6 Blasting

No guarantee is given or implied that blasting shall be accepted but should this method of removal be necessary and permitted, the Contractor must take all responsibility and observe all conditions set forth in all Government and Local Authority Regulations and/or bylaws.

## 8.3 Disposal Of Excavated Material

### 8.3.1 Backfilling

Material from the excavations, after testing by an accredited laboratory, where suitable and approved by the Engineer, is to be backfilled and compacted against foundation walls, under floors, steps, etc. as necessary.

No clay shall be used as filling.

### 8.3.2 Deposit on site

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Contractor

Witness 1

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Employer

Witness 1

Witness 2

The excess material shall be deposited on site, spread and levelled, where permitted.

### **8.3.3 Disposal off site**

Surplus material is to be carted away to an approved dumping site to be found by the Contractor, outside the boundary of the site.

## **8.4 Maintenance of Excavations**

### **8.4.1 Planking, strutting, etc.:**

Planking, strutting, shoring and temporary sheet piling shall be measured as such only when prescribed.

### **8.4.2 Risk of collapse**

The Contractor shall maintain all excavated faces exceeding 1,5 m deep in accordance with Government Regulations and all excavated faces not exceeding 1,5 m deep affecting the safety of the work and/or the workmen.

The Contractor shall carry the risk of collapse of excavated faces whether or not he takes any precautions, the nature of which shall be entirely at his own discretion.

## **8.5 Water In Excavations**

No water shall be allowed to accumulate in any portion of the excavations. The excavations shall be protected against any water entering them whether by seepage, rains, storms, floods or any other means. Any water found in the excavations shall immediately be removed by pumping or baling.

It is the Contractor's responsibility to keep foundations and excavations water free and the Contractor must supply all pumps etc. that may be necessary for clearing out the water. Water must be cleared in such a way that it cannot seep or flow back into the excavations.

## **8.6 Completion of excavations**

The Contractor shall give notice, in writing, to the Engineer when the excavations are ready to receive the foundations.

The foundations shall not be laid until the excavations have been approved of, in writing, by the Engineer and they shall not be covered until any variation has been measured.

## **8.7 Filling**

Filling shall be of approved clean earth in layers not exceeding 150 mm in depth, well watered, rammed and thoroughly consolidated to a minimum density of 90% Modified AASHTO density, which will be verified by the Engineer having it tested.

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Contractor

Witness 1

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Employer

Witness 1

Witness 2

All filling material shall be approved beforehand by the Engineer prior to placement. A 60 kg sample of the proposed fill is required for this purpose and fourteen days must be allowed for initial sample testing.

Before filling is placed, the virgin soil shall be scarified and compacted to at least 90% Modified AASHTO. Each layer of fill must be tested and approved by the Engineer before the next layer is placed and compacted.

a) To defined levels:

The ground outside the building(s) shown shall be made up with earth filling as above, finished level or graded to falls as shown on the drawings, or as directed. Sloping banks of made up ground shall be of such angle as will maintain the stability of the ground above, and shall be neatly trimmed.

b) To foundations etc:

Filling to foundations etc. shall be of earth filling as above. The filling of areas under solid floors shall be carried out as soon as the foundations and foundation walls have been completed.

c) Thicknesses of compacted material:

Thicknesses shown on drawing or given on site are those for compacted material. The Engineer shall keep notes on all filling supplied by the Contractor.

d) Rates:

Rates for all filling, including filling supplied by the Contractor from an off-site source, and separately measured, are to include for any necessary stockpiling and multiple handling.

### 8.8 Surplus Material

All surplus earth, topsoil and/or other materials from the excavations shall be deposited and levelled on the site, or carted away, as directed.

### 8.9 Gravel Dressing

Gravel dressing to the ground outside the building(s) shall be of approved clean gravel, well watered and consolidated by rolling with an approved roller to a hard even surface. The dressing shall be of a consolidated 75mm thickness.

### 8.10 Garden Soil Filling

Garden soil filling in flower boxes shall be rich, selected, well sifted soil containing the proper proportions of loam and leaf mould. The filling is to be placed and lightly consolidated.

### 8.11 Protection Against Termites

The ground under surface beds and below suspended wood floors shall be poisoned with an approved registered soil poisoning material of the chlordane or aldrin type mixed with water, applied at the rate of not less than 5 litres



Contractor



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Employer



Witness 1



Witness 2

of solution per m<sup>2</sup>. Great care is to be taken to apply the solution evenly over the whole surface. The concentration of the solution shall be in accordance with the Manufacturer's instructions and to the approval of the Engineer.

Where the ground to be treated is of earth filling, the upper layer of fill shall be levelled by raking, but where of natural ground, it shall be dug up, well loosened to a depth of not less than 50 mm so as to enable the solution to penetrate into the soil and similarly levelled. After the solution has been applied and allowed to soak in, the soil shall be well rammed and consolidated to at least 90% Modified AASHTO.

Before applying the solution to the ground under floors, 75 mm deep V-shaped channels shall be raked out alongside all walls enclosing the floors and against sleeper walls and piers etc. under floors and the channels flooded with poison solution. After the solution has soaked in, the channels shall be back filled and rammed.

The bottom of all foundation trenches and holes shall be similarly poisoned, but without digging up and loosening the soil.

The poisoned layer of soil under suspended wood floors shall be protected with a 75 mm thick layer of approved clean gravel or broken stone, levelled to an even surface on top, leaving a clearance as specified under Subclause 8.2.2 above.

Where concrete surface beds are laid above damp course level, the ground at damp course level shall be poisoned as above and a layer of clean earth filling laid on the poisoned ground up to underside of concrete beds, all well consolidated to at least 90% Modified AASHTO.

Great care shall be taken whilst laying the concrete floor beds, protective layers and filling to avoid rupturing the poisoned layer of soil under the floors. Should the poisoned layer be ruptured at any point it shall be made good and the affected areas treated again.

**Note:**

- a) The soil poison shall be delivered to the site in sealed containers, clearly labelled or stamped with the name of the product.
- b) Contractors are advised that special precautions must be taken to protect the workmen working with the soil poison.
- c) The poisoning of the ground under floors shall be done as soon as practicable, so that it may dry out before the floors are laid.
- d) The poisoning of the ground must be carried out under the supervision of the Representative/Agent.
- e) All Government laws and regulations, as well as those of local authorities' regarding termite poisoning, shall be strictly adhered to.

**9. MASONRY WORK**

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Contractor

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## 9.1 Mortar For Brickwork

Unless otherwise specified cement mortar for brickwork shall comprise four (4) parts by volume of sand and one (1) part by volume of cement for normal brickwork. The proportions for reinforced brickwork shall be three (3) parts sand and one (1) part cement.

The ingredients for the cement mortar shall be measured in proper gauge boxes. The material shall be mixed dry until of uniform colour and then water added and the mixture turned over until the ingredients are thoroughly incorporated

Cement mortar shall be produced in quantities that can be used before commencing to set, as no mortar that has commenced to set may be used in any way.

Care shall be taken in mixing cement mortar to remove from the mixing machine or platform any old mortar that has already set as such mortar may not be incorporated into any new batch.

## 9.2 Brickwork

### 9.2.1 General

All bricks shall be thoroughly wetted prior to laying and well bedded in mortar. Only whole bricks except where half bricks are required as closures shall be used.

Joints shall be 6mm maximum width in the case of exposed brickwork (unless otherwise specified in the Contract) and 10mm in the case of unexposed brickwork, and brickwork to be plastered.

Unless otherwise specified in the Contract, mortar joints shall be pointed as follows:

- Facing: Horizontal joints square, vertical joints flush.
- Unexposed brickwork: Flush
- Brickwork to be plastered or tiled scraped out 10 mm deep.

Brickwork generally shall be built in English bond. No false headers shall be used and none but whole bricks employed except where legitimately required to form a bond.

All brickwork shall be set out and built to the respective dimensions, thicknesses and lengths shown on the drawings or as directed by the Engineer.

The brickwork shall be carried up in a uniform manner. Brick walls shall be constructed such that no portion of a wall is more than one (1) metre higher than any other portion at any time.

All bricks shall be laid on a solid mortar bed well butted on all sides and joints fully grouted. Perpendes shall be truly perpendicular for the whole height of the building.

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Witness 1

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No brickwork shall be constructed during weather conditions that may adversely affect the appearance or the strength thereof.

Clay bricks shall be well saturated with water, in the stack or dump, approximately 2 hours before being used. The tops of walls left unfinished shall be well wetted before work recommences.

**Note :** Cement or concrete bricks shall not be wetted.

All rough and fair cutting, cutting of splays, skewbacks, chamfers, etc. shall be properly performed.

Form or leave all necessary openings for pipes etc. and make good after pipes etc. are fixed in position.

Brickwork shall generally be kept clean from mortar and defacing matter and shall be protected and finally cleaned as described below.

#### **9.2.2      Footing walls**

Wall footings, with all joints grouted in solid, will extend from the concrete foundation to floor level and in general be 457mm and 343mm wide for 28 mm and 230mm wide walls respectively.

External facing shall extend from the concrete foundation.

All brickwork below damp course level, all isolated piers three bricks wide and under, half brick thick walls and chimney stacks above ceiling level, shall be built in cement mortar as described in Clause 8.1.

Brick arches and brick lintels shall be built in cement mortar as described in Clause 9.1.

#### **9.2.3      Brickwork in thicknesses**

Walls built in two or three half brick thicknesses shall only be built where bonded brickwork proves impractical or where required due to the prescribed bond of faced brickwork,

Walls built in two or three thicknesses shall be tied together with metal ties in accordance with SANS 28 of sufficient length to allow not less than 75mm of each end to be built into brickwork and shall be spaced not more than 1 m apart to every third course and staggered.

#### **9.2.4      Brickwork in linings**

Linings to concrete shall be tied with 4mm diameter galvanised crimped wire ties with bent ends of necessary length to allow 75mm to be bedded into concrete and 75 mm of the other end to be built onto brickwork and evenly spaced 1m apart to every third course and staggered.

#### **9.2.5      Half brick thick walls**

Half brick thick walls shall be reinforced with 75mm wide brick reinforcement every eighth course in height, and built 100mm into main connecting walls. The reinforcement shall be lapped 150mm at end joints, where these are necessary, and 75mm at angles.



Contractor



Witness 1



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Witness 2

#### 9.2.6 Cavity walls

Cavity walls, unless otherwise specified, shall be built with two half brick thicknesses of brickwork in stretcher bond with 50mm cavity between, and the two thicknesses tied together with 200mm long metal wall ties, spaced at not more than 1m centres alternately to every third course of brickwork. The ties shall comply with the requirements of SANS specification 28 and be of the Butterfly type only.

The cavities shall be carried up from one course below damp course level up to two courses below roof plate level, unless otherwise shown or specified. The brickwork above cavities shall be built solid, and where 270mm thick shall be cut and well bonded where possible.

The cavities shall be kept free of rubbish, mortar droppings and protrusions and shall be protected against the ingress of rain water. The cavities shall not be ventilated.

At door, window and other openings, the cavities shall be stopped 110mm back from jambs of openings with the inner thickness of brickwork returned and stopped against the outer thickness and not bonded to same. A 110mm wide strip of damp proof sheeting shall be built in between the two thicknesses in the joint formed by the return and the outer thickness. The damp proofstrip shall be lapped at least 50mm on to the sheeting between the two thicknesses of sills and between the two thicknesses of lintels.

Sills to window shall be divided into external and internal thicknesses with strips of damp proof sheeting built in line with the damp proof sheeting in jambs and extending 100mm beyond the jambs of openings.

The lintels shall be provided with damp proof sheeting as described under lintels.

Unless otherwise specified, cavities shall be stopped one course below and one course above and 110mm from sides of openings for air bricks and the like.

#### 9.2.7 Beam filling

Beam filling, unless otherwise specified, shall be half brick thick, built in similar mortar as used in the walls below, cut in between roof timbers and carried hard up to underside of roof covering, and flushed up in mortar.

#### 9.2.8 Bagged finish to brickwork

Bagged finish to brickwork, if done whilst the mortar in joints is still soft, shall be formed by rubbing over the wall surfaces with wet rough sacking until all joints and crevices are filled up and an even surface is obtained. Mortar, as used for building the brickwork, shall be added as may be necessary.

If bagging to walls is done after the mortar in joints has set the wall surface shall be rubbed over with wet rough sacking as above, but cement grout shall be added as necessary to fill up the joints and crevices and to obtain an even surface.

#### 9.2.9 Raking out for and pointing flashings

Brick joints shall be raked out where required for fixing cover flashings, and flashings shall be pointed to 3:1

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cement mortar.

#### **9.2.10 Faced brickwork**

Faced brickwork shall be built fair and pointed with a keyed or recessed joint as specified.

Keyed joint shall mean that the joints are to be pointed with a round jointing tool, well pressed into the joints as the work proceeds.

Recessed joint shall mean that the joints are to be square recessed to a depth of approximately 6mm formed with a rectangular jointing tool well pressed into the joints as the work proceeds.

Facing bricks shall be sorted by the brick manufacturer at his yard or by the Contractor on the site to ensure that proper mixing of the bricks within the colour range of each type of facing brick being used is obtained. Sudden changes in the general colour of face work in any 1 type of facing brick will not be acceptable.

#### **9.3 Window Sills**

##### **9.3.1 Fibre cement sills**

Sills shall where in any way possible be in single lengths, cut between reveals, fitted with fixing lugs and solidly bedded in 3:1 cement mortar with a slight projection beyond the finished wall face below.

Internal sills shall be level. External sills shall be set sloping on cut brickwork.

##### **9.3.2 Quarry tiles**

Quarry tiles shall be of approved quality, even in thickness, truly square, free from cracks, twists and blemishes and uniform in colour and, unless otherwise specified, be of approved red colour.

Joints to quarry tiles shall be continuous in both directions with a free space around the perimeter.

Tiles shall be solidly bedded and jointed in 3:1 cement mortar with joints, unless otherwise specified, 6mm wide and pointed with a slightly keyed in joint. Tiles shall be well soaked in water before fixing and thoroughly cleaned off after fixing.

Tiles in sills, copings, etc. shall be set with slight projection over finished wall face, and where full tiles do not fit into the length, two cut tiles shall be used, symmetrically placed as directed.

#### **9.4 Building in of Frames, Pipes, etc.**

Door and window frames, lift door frames and the like shall be set up in position for building in and securely strutted to prevent distortion whilst the brickwork, lintels, etc. are being built.

Door and window frames shall be truly level and plumb and be firmly held in position with hoop iron fixing straps firmly built into the brickwork as the work proceeds.

The frames to lift doors are to be built in as the work proceeds and shall be placed in position by the Lift

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Contractor

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Employer

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Contractor.

Bricks shall butt hard up against frames and pressed steel door frames and lift door frames and shall be grouted in solid at back with cement mortar as the work proceeds.

Brickwork shall be carefully cut and built up around pipes etc. passing through walls such that courses remain neat and regular and joints match.

Ends of timbers, holdfasts, cramps, gratings, air bricks, dowels, etc. shall be built-in in cement mortar. Wood slips, fixing bricks, hoop iron roof ties, etc. shall be built in as the work proceeds.

### 9.5 Hollow Tile Lintels

Hollow tile lintels shall be formed with approved 300 x 220 x 110mm burnt clay hollow tiles, each having not more than three cavities. The tiles shall be set end to end and the cavities filled up solid with Class 25/40 concrete. Lintels shall have bearings of not less than 220mm on walls at ends.

The lintels over the various size openings shall be reinforced as specified in the following table.

| CLEAR SPAN, Metre | REINFORCEMENT                                                |
|-------------------|--------------------------------------------------------------|
| Not exceeding 1   | One 12mm diameter mild steel rod in upper and lower cavities |
| Over 1 to 1,5     | One 16mm diameter mild steel rod in upper and lower cavities |

The reinforcing rods shall be placed 12mm from top and bottom edges of concrete filling to upper and lower cavities respectively.

Lintels over openings not exceeding 1 m wide, in one brick thick walls, shall be on flat, and in all other cases shall be on edge, using two or more lintels in walls one brick thick and over, built side by side, to make up the thicknesses of walls.

Lintels in 270mm thick cavity walls be in two 110mm thicknesses with inner face of outer thicknesses covered with sheeting as for damp course, the full length and depth of lintel, and the space between the two thicknesses filled in solid with Class 25/40 concrete. Where cavities continue above lintels the sheeting in lintels shall be taken up and turned on to top of first course of brickwork to inner thickness of wall, above the lintels.

Lintels shall be made not less than 21 days before building in, and shall be cured for at least 14 days by being kept damp in a shaded position.

The lintels shall be hoisted into position and bedded and grouted in solid in cement mortar.

### 9.6 Reinforced Brick Lintels



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Reinforced brick lintels shall be built with sound machine made bricks with all vertical and horizontal joints filled solid with mortar throughout the required number of courses and to a distance of at least 330mm on either side of the clear opening.

The number of courses in lintels over the various size openings shall be as specified in table hereunder, and reinforcing steel wires or rods shall be built into the first horizontal joint over the bottom course as laid down therein viz.:

| CLEAR OR DAYLIGHT SPAN, Metres | NUMBER OF COURSES | REINFORCEMENT                                                                                     |
|--------------------------------|-------------------|---------------------------------------------------------------------------------------------------|
| Not exceeding 1                | 4                 | One row of 75 mm wide brick reinforcement as described below, for each half brick width of soffit |
| Over 1 to 1,5                  | 6                 | Ditto                                                                                             |
| Over 1,5 to 2,5                | 7                 | Three 6,3 mm diameter mild steel rods for each half brick width of soffit                         |
| Over 2,5 to 3,0                | 8                 | Ditto                                                                                             |

Brick reinforcement shall be of hard drawn mild steel comprising two 3,15mm diameter cross wires spaced at not exceeding 300mm apart, welded to main wires.

The reinforcement wires and rods shall be of length at least equal to the width of the clear opening plus 330mm at each end. The reinforcement shall be evenly spaced in the brick joints, with the outer wires or rods having at least 20mm cover from face of brickwork.

Brick lintels in 270mm thick cavity walls shall be built in two half brick thicknesses in stretcher bond, with inner face of outer thicknesses, for a depth of three courses above soffit, covered with sheeting as for damp course the full length of lintels, and space between the two thicknesses for the depth of the sheeting filled in solid with Class 25/40 concrete. Where cavities continue above lintels, the sheeting shall be taken up and turned on to top of first course of brickwork to inner thickness of wall, above the concrete filling in lintels. The sheeting is not required in lintels protected from the weather.

The lintels, except where built over pressed steel door frames and the like, shall be supported on temporary formwork left in position for at least 14 days.

### 9.7 Prestressed Lintels

Prestressed lintels shall be vibrated concrete reinforced with stressed high tensile steel wires.

Concrete in lintels shall attain a crushing strength of at least 34 MPa at 28 days for ordinary and at 7 days for rapid hardening cement.

The reinforcing wires shall be of ductile high tensile steel wire not less than 4 mm diameter and of tensile strength of at least 1 350 MPa and shall be stressed to not less than 850 MPa.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The lintels may be in a single width to the thickness of wall or may be in two widths, placed side by side, and shall have a depth of not less than 60mm. Top surface of lintels shall be suitably roughened, indented or shaped to give a good bond between the lintels and the mortar for the first course of brickwork above.

Lintels shall have bearings of not less than 225mm on walls at each end.

The number of reinforcing wires in lintels for the various wall thicknesses and spans shall be not less than specified in the table hereunder, and brick courses over lintels of the number indicated in the table and for the full length of lintels shall be built in 3:1 cement mortar with all joints filled solid with mortar, viz:

| Nominal wall thickness (mm) | Clear or daylight span                                     | Number of wires (in total number of lintels used) | Number of brick courses over lintel |
|-----------------------------|------------------------------------------------------------|---------------------------------------------------|-------------------------------------|
| 90 – 110                    | Not exceeding 1,8m                                         | 2                                                 | 3                                   |
| 90 – 110                    | Over 1,8m to 3m Not exceeding 1,8m                         | 3                                                 | 4                                   |
| 180 – 230                   | exceeding 1,8m                                             | 6                                                 | 4                                   |
| 180 – 230                   | Over 1,8m to 3m                                            | 6                                                 | 5                                   |
| 270                         | Not exceeding 1,8m Over                                    | 7                                                 | 4                                   |
| 270                         | 1,8m to 3m                                                 | 7                                                 | 5                                   |
| 34                          | As described for 1 of 230mm plus 1 of 110mm, or 3 of 110mm |                                                   |                                     |

Lintels in 270mm thick cavity walls shall be in two widths with joint between the two arranged directly over the window or frame below, and the brickwork above shall be built in two half brick thickness with inner face of the outer thickness covered with sheeting as for damp-course, the full length and depth of lintels, and taken down between the two widths of pre-stressed lintels. The cavity to height of lintel courses shall be filled with Class E concrete, and where cavities continue above the lintel courses the sheeting shall be taken up and turned on to top of first course of brickwork to inner thickness of wall above the lintel course. The sheeting is not required in lintels protected from the weather.

## 9.8 Mastic Pointing

Where steel door and window frames are specified to be pointed with mastic compound they shall be pointed all round externally with an approved waterproof compound, of such composition that it will not stain surrounding surfaces, and that it will adhere tenaciously, remain plastic without sagging or running, be capable of accommodating any normal movement of the joint sealed, and will receive paint without "bleeding". The pointing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

material shall be forced into the joints, which shall have been previously prepared to receive same, by means of a pressure gun, or by other suitable method, all in accordance with the manufacturer' instructions.

### 9.9 Smoke Flues

Smoke flues, unless otherwise specified, shall be 220 x 220mm, and carried up as straight as possible with easy bends where necessary.

Flues not lined with firebricks, or similar material, shall be parged with mortar and cored at completion. Firebrick linings to flues shall be one half brick thick, built to fair face, bedded and jointed in approved fireclay or forecement and flush pointed, and properly cleaned out as the work proceeds.

The flues shall be properly gathered over fireplace openings, and where flues start from top of flue slabs steep flaunching, of Class 25/40 concrete, shall be provided on slab, worked up round flue, to prevent lodgement of soot and the slab.

### 9.10 Fixing Strong Room Doors and Ventilators

Strong Room doors shall not be built into walls as the work proceeds but shall be set up and fixed into openings formed in the walls, after plastering, etc., has been completed, and secured in position with grip lugs supplied with doors and grouted in solid all round with 3:1 cement mortar, all in accordance with the manufacturers' instructions, and floor and wall finishes made good if disturbed.

Ventilators to Strong Rooms shall be built into openings formed in the walls, in 3:1 cement mortar, and grouted in solid with similar mortar and wall finishes made good if disturbed.

### 9.11 Securing of Roofs

Roof plates shall be fixed to walls with bands of 1,6 mm thick galvanised hoop iron, 32 mm wide, built 750mm deep into brickwork or embedded 300 mm deep into concrete, at not exceeding 1,5m centres, and well lapped and spiked to plates and to roof trusses where adjacent, otherwise taken up to and lapped round the nearest purlin and well spiked thereto.

### 9.12 Cramps to Wood Frames

Wood frames to doors, windows, etc., shall be set up in position for building in as described and built in as the work proceeds with cramps to jambs of 1,6mm thick galvanised hoop iron, 32mm wide, with ends turned 50mm up against stiles of frames and each twice screwed to frame, and built 450mm into wall with end turned up into brickwork joint. Cramps shall be built in approximately 0,3m up from bottom and approximately 0,3m down from head of frames and intermediately at not exceeding 0,85m apart. No frame shall have less than two cramps to each jamb irrespective of height.

Cramps to frames in 270mm thick cavity walls shall be cranked as necessary and built into inner and outer thicknesses of walls alternately.

### 9.13 Bedding and Pointing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

All door, window and similar frames shall be bedded and pointed in 3:1 cement mortar. All plates shall be bedded in 5:1 cement mortar.

Steel door and window frames be carefully pointed all round and made perfectly watertight.

Where steel door and window frames are specified to be pointed with mastic compound they shall be pointed all round externally with an approved waterproof compound, of such composition that it will not stain surrounding surfaces, and that it will adhere tenaciously, remain plastic without sagging or running, be capable of accommodating any normal movement of the joint sealed, and will receive paint without "bleeding". The pointing material shall be forced into the joints, which shall have been previously prepared to receive same, by means of a pressure gun, or by other suitable method, all in accordance with the manufacturer's instructions.

#### **9.14 Special Works**

The work in connection with the installation of heating, air conditioning, ventilation, refrigeration, automatic sprinkler, telephone systems and lifts will be carried out under separate contracts or departmentally, and in order to facilitate the work the Contractor must act on the instructions of the Engineer in regard to special preparations for fittings, leaving holes and openings, or forming chases in floors, walls, etc., for pipes, cables, etc., and for building in pipes, sleeves, pipe clips, bolts, etc., as required or directed.

All cutting of holes through finished floors, walls, etc., after the concrete has set, must be avoided as far as possible, and the Contractor must give ample notice to the Engineer who will ascertain the exact positions where pipe sleeves, pipes, pipe clips, etc., are to be fixed.

#### **9.15 Protect and Clean Down Brickwork**

Angles of face brickwork, reveals, steps, etc., liable to damage shall be covered up and protected during the progress of the remaining work, and any damage done shall be made good to the satisfaction of the Engineer.

Face brickwork and brick and tile sills, copings, etc., shall be cleaned down as the work proceeds and surfaces liable to be soiled by mortar or plaster splashes during the progress of the remaining work, shall be covered with paper pasted on, or by other approved means. On completion of the works the coverings shall be removed and the surfaces again cleaned down to the satisfaction of the Engineer.

Any detergent or other materials used in the cleaning down of face brickwork, etc., shall be of such nature that will not harm adjoining paint and other finishings in any way.

All tiles and other paving shall be thoroughly cleaned off after laying to remove all traces of mortar and other substances, covered up and protected from damage during the progress of the works, and again cleaned off at completion.

### **10. INSTALLATION OF ELECTRICAL SERVICES**

The installation of electrical service, where such service is being provided, will be carried out under separate contract but the Contractor must embed in the concrete, as the work proceeds, all conduits, boxes, etc., which will be fixed in position by the electricians, and must cut all necessary chases and holes in walls for conduits and



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

form recesses in walls for distribution boards, all in the positions directed. Alternatively, distribution boards may be built into walls as the work proceeds, providing prior approval is obtained from the Representative/Agent.

The Contractor shall afford every facility and shall render reasonable assistance to the electricians in carrying out their work and shall make good where necessary, in all trades, after installation has been completed.

Chases, holes and recesses required in walls shall be cut and formed as follows:

- Vertical chase for single conduit.
- Vertical chase for two conduits.
- Vertical chase 150mm wide and 110mm deep for conduits.
- Vertical chase 250mm wide and 110mm deep for conduits.
- Vertical chase 380mm wide and 110mm deep for conduits.
- Vertical chase 560mm wide and 110mm deep for conduits.
- Horizontal chase for single conduit.
- Holes 25mm diameter, or knocking out bricks and filling space and making good after a pipe has been fixed through a wall.

#### Recesses for distribution boards

| Width mm | Height mm | Depth mm |
|----------|-----------|----------|
| 330      | 330       | 110      |
| 455      | 330       | 110      |
| 635      | 330       | 110      |
| 610      | 660       | 110      |
| 610      | 910       | 110      |

#### 10.1 Cable Sleeves

Provide under buildings where required 100mm diameter vitrified clay, pitch fibre or plastic pipes as sleeves for electric cable taken up to floor level in cable duct or switch cupboard with easy bends.

The pipes shall be as specified for drainage including laying and jointing.

#### 10.2 Special Works

The work in connection with the installation of heating, air conditioning, ventilation, refrigeration, automatic sprinklers, telephone systems and lifts will be carried out under separate contracts. In order to facilitate this work the Contractor must act on the instructions of the Engineer with regard to special preparations for fittings, leaving



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



holes and openings, forming chases in floors, walls, etc. for pipes, cables, etc. and for building in pipes, sleeves, pipe clips, bolts, etc. as required or directed.

All cutting of holes through finished floors, walls, etc., after the concrete has set, must be avoided as far as possible. The Contractor must give ample notice to the Engineer who will ascertain the exact positions where pipe sleeves, pipes, pipe clips, etc. are to be fixed

## **11. PLASTERING**

### **11.1 Lime**

Lime shall be hydrated plaster lime complying with the requirements of SANS 523.

### **11.2 Cement**

Cement shall be as described in Clause 6.1.

### **11.3 Sand**

Sand for plaster shall be as described in Clause 6.2.

### **11.4 Forming Key to Concrete for Plaster Finish**

All surfaces of concrete receiving plaster or similar finishes shall be well wetted and wire brushed immediately the formwork has been removed and slushed over with 2:1 cement grout to form key for the finish, all to the approval of the Representative/Agent. The slushing shall be allowed to set hard before any finish is applied.

### **11.5 Lime Plaster**

#### **11.5.1 One coat work on walls**

Lime plaster for 1 coat work on walls shall be composed of 4 parts by volume of sand and 1 part by volume of lime. The material shall be mixed dry until of uniform colour, water shall then be added and the mixture turned over until the ingredients are thoroughly incorporated.

Lime plaster not used on the day it is mixed, shall be kept moist until required for use by covering with wet sacks or by other approved means.

#### **11.5.2 Two coat work on walls**

The rendering coat shall be of compo plaster as described in Clause 11.6 well scratched over to form key for the setting coat. The setting coat shall be composed of 1 part hydrated putty plaster lime, complying with the requirements of SANS 523 referred to in Clause 11.1 and 1 part fine washed sand, to which retarded hemi-hydrate hardwall finishing gypsum plaster shall be added in the proportion of 1 part of gypsum plaster to 4 parts of sand, all proportioned by volume.

The gypsum plaster shall not be added to the mixture until the setting coat is to be applied and shall then be

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thoroughly incorporated into the mixture and used immediately.

#### **11.5.3      Two coat work on metal lathing**

The rendering coat shall be of compo plaster as described in Clause 11.6 to which sisal shall be added in the proportion of 4 kg of sisal to 1 cubic metre of plaster. The rendering coat shall be well scratched over to form a key for the setting coat.

The setting coat shall be all as described in Subclause 11.5.2.

#### **11.6              Compo Plaster**

Compo plaster shall be composed of 10 parts of sand, depending on the quality of the sand available, 1 part lime and 1 part cement all measured by volume.

The lime and sand shall be mixed dry until of uniform colour and then mixed wet. Approximately half an hour before use, add the cement and any additional water as may be required and remix until thoroughly incorporated.

Compo plaster shall be produced in such quantities as can be used whilst remaining workable as no compo plaster that has become unworkable shall be used in any way.

#### **11.7              Cement Plaster**

##### **11.7.1      One coat work on brickwork**

Cement plaster for 1 coat work on brickwork shall be composed of 4 parts of sand to 1 part of cement for internal work and 5 parts of sand to 1 part of cement for external work, all measured by volume, and mixed as described for cement mortar in Clause 59.1

##### **11.7.2      One coat work on concrete ceilings and beams**

Cement plaster to concrete ceilings and beams shall be composed of 3 parts of sand to 1 part of cement, all measured by volume and mixed as described for cement mortar in Clause 9.1.

##### **11.7.3      Two coat work on brickwork**

The rendering coat shall be as described in Subclause 11.7.1, well scratched over to form key for the setting coat. The setting coat shall be composed of 1 part of cement, 2 parts of putty plaster lime as described in Subclause 11.5.2 and 1 part of fine washed sand, all measured by volume.

The cement and putty plaster lime shall not be added to the mixture until immediately before the setting coat is to be applied and shall be thoroughly incorporated in the mixture and shall be used immediately.

#### **11.8              Hardwall Gypsum Plaster**

Hardwall gypsum plaster shall be a retarded semi-hydrate hardwall gypsum plaster of finishing quality, gauged with a small percentage of well slaked lime putty, mixed in strict accordance with the manufacturer's instructions

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Contractor

Witness 1

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Employer

Witness 1

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or a hemi-hydrate neat finishing gypsum plaster, applied over a rendering coat of cement plaster, in two thicknesses by the trowel-float-trowel method.

The rendering coat shall be of 4:1 cement plaster as described in Subclause 11.7.1, all well scratched over to form key for the setting coat.

#### **11.9 Concrete Bonding Plaster**

Concrete bonding plaster shall be a retarded semi-hydrate wood fibre concrete bonding gypsum plaster, applied in two thicknesses by the trowel-float-trowel method to a total thickness of not less than 6mm and finished with a very thin layer of finishing plaster as described in Clause 11.8, applied immediately the second layer of bonding plaster stiffens.

#### **11.10 Plasterboard Bonding Plaster**

Plasterboard bonding plaster shall be a light weight retarded hemi-hydrate gypsum plaster, applied in two thicknesses by the trowel-float-trowel method, to a total thickness of not less than 6mm, well pressed into the wire scrim over the joints between the ceiling boards and finished with a very thin layer of finishing plaster as described in Clause 11.8. The finishing plaster shall be applied as soon as the second layer of bonding plaster stiffens.

For gypsum base boarding to ceilings see Subclause 14.2.2.

#### **11.11 Thickness of Plaster**

Plaster on walls shall be not less than 12mm or more than 20mm in thickness and plaster on concrete ceilings and beams shall be not less than 9mm or more than 16mm in thickness.

#### **11.12 Application of Plaster**

Walls shall be well wetted before plastering is commenced.

The surfaces of plastered walls internally shall be steel trowelled to a smooth, even and true finish.

All external plaster shall be finished to a true and even surface with a wood float. All plaster surfaces shall be free from blemish.

Plaster shall be returned into reveals and soffits of openings and all angles shall be true and straight with salient angles slightly rounded.

The rendering coat of plaster in two coat work shall be approved by the Engineer before the setting coat is applied and notice shall be given to the Engineer when the plaster is ready for inspection.

All cracks, blisters and other defects shall be cut out, made good and the whole left perfect at completion.

**Note :** See Clause 11.4 for forming key for plaster on concrete.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

### 11.13 Granolithic Finish (For sand-cement finish see Clause 11.19)

Granolithic finish to floors, treads of steps, thresholds and similar horizontal surfaces shall be not less than 25mm thick, composed of 2 parts granite, or other approved hard stone chippings, or approved hard coarse sharp washed granitic or quartzitic river sand, graded up to a maximum size of 5 mm, 1 part clean pit sand screened through a 2,4 mmmesh sieve and 1 part of cement. The screed shall be hand or mechanically steel trowelled to a true and smooth surface.

The material must test between 30 and 35MPa. No dry cement powder or grout shall be applied to the surface.

The granolithic shall be laid before the concrete subfloor has matured otherwise the exposed surface of the concrete shall be thoroughly cleaned with a wire brush and a coat of neat cement grout applied immediately before the granolithic is laid.

The granolithic finish shall be laid in panels not exceeding 20m<sup>2</sup> in area and joined to lines of panels with V-joints as directed. The length of any panel shall not exceed 4,5 m and wherever possible the joints between the panels shall coincide with any joints in the concrete sub-floor.

Where granolithic is to be tinted, it shall be laid in two thicknesses in one operation, the lower thickness being brought up to within 6mm of the finished level and the upper thickness, into which the requisite quantity of approved colouring material has been mixed, shall be laid. NO DUSTING OF COLOURING MATERIAL WILL BE ALLOWED.

Granolithic finish to stair risers, sides of kerbs and other vertical surfaces shall be not less than 12mm thick.

Exposed salient angles of granolithic shall be neatly rounded to approximately 20 mm radius.

All granolithic work shall be carried out by experienced workmen and shall be protected from damage caused by rain or other extremes of weather for 12 hours after being laid, and against drying out too rapidly whilst hardening by covering with wet sacks or other suitable material and shall be protected from other damage and discoloration during the progress of the remaining work.

Edges of granolithic floors adjoining other floor finishes, edges of margins, etc. shall be true and sharp, all protected by fixing temporary wood strips which shall remain in position until laying of the adjoining flooring material is commenced.

### 11.14 Granolithic Skirting

Granolithic skirting shall be formed by turning the granolithic floor finish up against walls and other vertical surfaces, hollow rounding the granolithic at junction with floors and finishing the top edge perfectly straight. The skirting shall be at least 75mm high.

Skirting shall finish flush with glazed wall tiling, but shall project approximately 5mm beyond the face of plastered wall surfaces and 10mm beyond faces of face brick and bagged wall surfaces.

Projecting top edges of skirting shall be slightly rounded.



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All mitres, stopped and returned ends, etc. shall be neatly formed.

#### **11.15 Granolithic Stoolings**

Granolithic stoolings under jambs of door frames etc. shall be formed in Class E concrete with granolithic finish as for floors and of same height and shape as the granolithic skirtings, all to finish flush with jambs of door frames where skirtings finish flush with wall face and projecting beyond stiles to match skirtings, where skirtings project beyond face of wall.

All mitres etc. shall be neatly formed.

#### **11.16 Reedings to Steps Etc.**

The treads of steps and upper surfaces of external thresholds finished with granolithic or sand- cement finish shall be rendered non-slip by reeding the same near front edge for a width of 100mm and stopped 100mm from ends.

#### **11.17 Polishing of Granolithic Finishes**

All tinted granolithic finishes to floors, steps, thresholds, skirting, etc. shall at completion of all otherwork be twice polished with wax floor polish of approved type.

#### **11.18 Screeding To Floors**

Concrete sub-floors finished with wood mosaic, semi-flexible tiles and fully flexible vinyl sheeting and tiles and similar finishes shall be screeded with 3:1 cement plaster of thickness required, but in no case less than 12mm, all steel trowelled to true and smooth surfaces. The sand used in the plaster shall be of such fineness as will allow for the screed being trowelled to a surface suitable to receive the finishes.

The screeding shall be laid before the concrete sub-floors have matured, otherwise the exposed surfaces of the concrete shall be thoroughly cleaned with a wire brush and a coat of neat cement grout applied immediately before the screeding is laid.

The screeding shall be laid in good time, but no finishes are to be laid if the screed exceeds 70% moisture content when measured with a hygrometer.

No traffic shall pass over nor shall any building operations take place on the screeding unless a proper protective covering is first provided.

#### **11.19 Sand-Cement Finish**

Sand-cement finish to treads of steps, thresholds, etc. shall be of 2:1 cement plaster not less than 20mm thick and steel trowelled to true and smooth surfaces. If specified to be tinted the requisite quantity of approved colouring pigment shall be mixed in as no dusting of colouring material will be allowed. The finish to risers of steps, sides of kerbs and other vertical surfaces shall be not less than 12mm thick. Exposed salient angles shall

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be neatly rounded to approximately 20mm radius.

The floors of lift motor rooms and lift pits are to be finished in accordance with the requirements of the Lift Contractor.

## **12. WATERPROOFING**

### **12.1 Damp-Proof Course**

The horizontal and vertical damp-proof course shall be of black polyethylene sheeting complying with SANS Specification 952 Type B having embossed surfaces, 0,38mm thick (375 microns) and manufactured in widths of less than 1000mm.

The damp-proof course shall be the full thickness of walls above foundations, plus the width of floor plates where these occur, and shall be laid without longitudinal joints. At end joints, angles and intermediate junctions the sheeting shall be lapped for 150mm.

Where so required all laps in the damp-proof course shall be sealed over the whole area of laps as recommended by the Manufacturer. Care shall be taken not to tear or otherwise damage the sheeting.

Similar damp-proof course, 120mm wide x 250mm long, shall be laid on sleeper piers under the floor bearers.

Similar damp-proof course, but in unbroken lengths, shall be laid behind all window sills, sealed with an approved bituminous solution to the back of the sills and taken down within the thickness of the wall and under the first full course of external brickwork.

**Note :** No damp-proof course shall be laid directly below the mortar or other bedding material under sills.

### **12.2 Damp-Proof Membrane**

The damp-proof membrane under surface beds shall, unless otherwise specified, be of green polyethylene sheeting complying with SANS Specification 952 Type C — plain surface ~ 0,25mm thick (250 microns) and manufactured in widths of 1000mm and greater, all laid in the widest practical widths to minimise joints, turned up and dressed to load bearing walls and, if applicable, lapped with the damp-proof course in the walls. All joints shall be sealed with pressure sensitive tape applied over the leading edge of the joint.

**Note :** All cutting of plastic membranes shall be carried out using sharp instruments.

### **12.3 Tanking**

Horizontal and vertical tanking shall, unless otherwise specified, be as hereunder and carried out in accordance with SANS Code of Practice 021:

- a) of bituminous sheeting complying with the requirements of SANS Specification 248 and as Type FV (Fibre Felt Base) or Type GH (Hessian Base) sheeting specified therein as—



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- (i) one layer lapped 75mm at edges and ends and sealed together with hot bitumen. (The sheeting laid free of the sub-floor but sealed to primed walls); or
  - (ii) (ii) two layers laid shingle fashion, lapped 475mm at edges and 150mm at ends and sealed together with hot bitumen. (The sheeting laid free of the sub-floor but sealed to primed walls); or
  - (iii) (iii) three layers laid shingle fashion, lapped 617mm at edges and 150mm at ends and sealed together with hot bitumen. (The sheeting laid free of the sub-floor but sealed to primed walls); or
- b) of polymeric sheeting complying with the requirements of SANS Specification 952 and as Type C — plain surface — specified therein as —
- (i) one layer Orange EVA polyethylene sheeting, 1,00mm thick (1000 microns), lapped and jointed with the specially formulated joining strip to form a fully waterproof seal, all strictly in accordance with the Manufacturer's instructions; or
  - (ii) one layer Orange EVA polyethylene sheeting, 0,50mm thick (500 microns), lapped and jointed with the specially formulated joining strip to form a fully waterproof seal, all strictly in accordance with the Manufacturer's instructions; or
- c) of an approved torch-on type of material, 4mm thick, consisting of polymer modified bitumen, all laid strictly in accordance with the Manufacturer's instructions, with 100 mm side and end laps fully bonded.

The manufacture of such material shall comply with SANS Code of Practice 0157.

**Note :** Approved filling shall be carefully placed against tanking material for the full height of same and shall be free of stone or other hard, sharp particles larger than will pass a mesh of 10mm in the clear.

If the material from the excavations is found to be unsuitable, written approval must first be obtained from the Engineer to use imported fill.

## **12.4 Flat Roof Covering**

### **12.4.1 General**

The work of covering flat roofs shall be carried out by skilled workmen who are experienced in this type of work, all in accordance with SANS Code of Practice 021.

Surfaces to be covered shall be perfectly dry and, immediately before the material is laid, swept clean of all chips, dust, etc.

No burnt mastic shall be used in the work.

The Contractor shall furnish the Department with a written guarantee covering the time period stated for each



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type of roof covering specified, the workmanship and materials. This guarantee shall be signed by the Contractor and countersigned by the supplier of the materials used.

It is a specific requirement that the guarantee for the flat roof waterproofing specified or offered, be underwritten by a recognised insurance company.

Should any maintenance be required during the guarantee period the Contractor must allow for the cost of such in his tender price as the Contractor will be held solely responsible for any leaks that occur during the guarantee period.

#### **12.4.2 Bituminous Sheeting**

Covering to flat concrete roofs shall be of two or three layers of Type 60 bituminous sheeting, as specified, having a mass of not less than 57 kg per roll of 18 m<sup>2</sup>, all in accordance with SANS Specification 92.

The sheeting is to be unrolled on to the surface to be covered and allowed to warm in the sun to remove all wrinkles and to ensure that the material is perfectly flat when laid in position. All layers and lappings are to be sealed together with hot bitumen.

The hot bitumen is to be applied at a rate of not less than 1,5 kg/m<sup>2</sup> of roofing between each layer. Where direct adhesion of the bituminous sheeting to the concrete deck occurs such as perimeters, turn-ups and turn-downs, etc. the respective areas must be primed with bituminous primer and allowed to dry before any sealing with the hot bitumen takes place.

Turn roof covering up, over triangular fillets, against vertical surfaces for a total height of not less than 100mm. The turn-ups and turn-downs are to be well fixed to all angles and fillets, well dressed around pipes and into outlets and finished off with a fibre bitumen fillet where applicable. Dress the full thickness of the roof covering to splayed edge of outlets as well as to all other relevant surfaces.

All sheeting is to be laid shingle fashion with not more than 283mm exposure of each sheet in three layer work, and 424mm exposure in two layer work, all laid with 150mm end laps.

The surfaces, unless otherwise specified, must be finished on top with a heavy brush application of bituminous based aluminium paint complying with SANS Specification 802.

On completion the work shall be thoroughly sound and guaranteed to remain water tight for a period of 10 years for 3-layer work and seven years for 2-layer work.

#### **12.4.3 Polyester based sheeting**

Covering to flat concrete roofs shall consist of an approved single layer system of 4mm thick, torch-on, polymer modified bitumen with polyester base, protected on exposed surfaces with UV resistant mineral chip coating applied during manufacture of the sheeting.

The sheeting shall be laid in strict accordance with the Manufacturer's instructions with 75mm side laps and 100mm end laps, all fully bonded.

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All concrete surfaces to be covered with torch-on sheeting are to be primed with a suitable bituminous primer at the rate of 3,5 m<sup>2</sup>/litre and allowed to dry.

The waterproofing system shall be manufactured in accordance with SANS Code of Practice 0157.

On completion the work shall be thoroughly sound and guaranteed to remain watertight for a period of 10 years.

### **13. ROOF COVERINGS**

#### **13.1 General**

Prior to the laying of tiles or slates, the roof structure shall be covered with an approved waterproofing underlay having a non-combustible reflective foil finish on upper surface and a layer of plastic on the underside all bonded to a substrate of kraft paper having synthetic reinforcing, all as described in SANS Specification 1381.

The waterproofing underlay shall be laid longitudinally and pulled taut over the top edges of the rafters and then nailed thereto with galvanised clout nails. Working from the eaves level upwards, a minimum overlap of 150mm shall be allowed to ensure complete protection.

Roofs shall be left perfect, clean and watertight on completion and all eaves and valley gutters shall be cleaned out.

Valleys shall be of open or closed construction as follows:

- a) Open valleys: a strip of underlay approximately 1 m wide shall be laid along the whole length of the valley and nailed into position with clout nails close to the edges of the valley boards farthest from the centre line of the valley. Provide metal valley lining as described in Clause 7.15, ensuring that it extends at least 50mm beyond the edges of the tiling, all securely fixed along both edges. Matching roof tiles/slates shall be neatly cut to the line of the valley and laid to project over the edges of the valley lining by at least 50mm. A gap of at least 50mm shall be provided down the centre line of the valley between the edges of the tiles.
- b) Closed valleys: all constructed as for open valleys except that the tiles are to be cut in such a manner that when laid they form a butt joint closing valley.

#### **13.2 Roofing Tiles (Clay)**

Clay roofing tiles shall comply with the requirements of SANS Specification 632 and shall be of the pattern specified.

Unless otherwise specified, the tiles shall be of an approved red colour.

Plain tiles shall be laid "broken bond" and vertical joints between tiles and the bottom edge of each course of tiles shall range perfectly straight and, unless otherwise specified, shall be laid to a lap of at least 62mm.



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Half tiles in the case of interlocking tiles and tile-and-a-half tiles in the case of plain tiles shall be provided as required at abutments and at verges of roofs. Plain tile roofs shall be provided with a double course at eaves.

Tiles shall be carefully cut and dressed at hips, valleys and where necessary at abutments etc. Unless otherwise specified, tiles shall be securely fixed as follows:

- a) Interlocking tiles: every tile in every third course shall be secured using 1,6mm diameter galvanised steel wire passed through the holes in nibs and wound around battens for inland use whilst copper, aluminium or Grade 304 stainless steel wire shall be used in coastal areas.
- b) Plain tiles: every tile in every fifth course shall be secured using copper, aluminium or Grade 304 stainless steel nails for all services, coastal or inland. All nails shall be of such length as will penetrate the battens to a depth of at least 25mm.

**Note :** All tiles in ridge courses, all cut end tiles along each side of valleys and hips and all tiles to open eaves and verges shall be secured with wire or nails as specified above. Where necessary the mitred portions of tiles along each side of valleys and hips are to be holed and properly secured with wire or nails as above.

#### Ridges and Hips:

Hip and ridge tiles shall be half-round, of the same material and manufacture as the roofing tiles, with a minimum cover of 75mm on each side over the top course of tiling and with collars for overlapping joints, all bedded and pointed in 3:1 cement mortar. All hip tiles and every fourth ridge tile shall be holed for and fixed with Grade 304 stainless steel nails for all areas. The hip and ridge junction tiles, stopped ends, etc. shall be of approved design, made to work in with ridging and ordinary tiles and bedded and pointed as before.

### **13.3 Roofing Tiles (Concrete)**

Concrete roofing tiles shall comply with the requirements of SANS Specification 542 and shall be of pattern and colour specified.

The body of each tile shall be of such a colour throughout that the colour of any part of the surface that may be abraded or worn away will resemble or tone in with that of the rest of the surface.

Tiles shall be laid to a lap of at least 100 mm in the case of roof pitches between 17 ½° and 25° and in the case of roof pitches 26° and upwards to a minimum lap of 75mm. Vertical joints between tiles and the bottom edges of each course of tiles shall range perfectly straight.

Unless otherwise specified tiles shall be securely fixed as follows:

- a) Every third tile in each course; all tiles in ridge courses; all cut end tiles along each side of hips and valleys; all tiles to open eaves and verges shall be fixed to the battens with copper, aluminium or Grade 304 stainless steel clout nails for all areas. All nails shall be of such length as will penetrate the battens to a depth of at least 25mm.



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- b) For coastal areas all tiles are to be clipped using approved nylon storm clips nailed to the tile battens.

#### Ridges and Hips:

Ridges and hips shall be covered with collared or butt jointed, half-round or angular ridge tiles, all of colour to match the general tiling. A strip of DPC sheeting as described in 6.1, of such width as will give a lap of at least 75mm on to the roof tiling at each side and lapped not less than 100mm at end joints, shall be laid under the mortar bedding. All mortar shall consist of 3 parts clean fine sand to 1 part of cement, pigmented to approved colour, for both bedding and pointing.

Pointing shall not be performed with separate materials and no lime shall be added. Only inorganic pigment shall be used at all times to colour the mortar and match the shade of the tiles used.

Painting with pigmented mortar or pigment/water concentrate is not acceptable.

Butt ended ridge tiles shall be bedded solid with the 3:1 mortar squeezed up to fill the joint and struck off cleanly. Where a large mass of bedding mortar is required, e.g. junctions of ridge/hip tiles or in the troughs produced by deeply contoured tiles, broken pieces of tiles shall be used to prevent excessive shrinkage and cracking of the mortar. The mortar bedding shall be trowelled smooth at exposed ends of ridges.

Hip and ridge tiles shall be neatly cut and fitted together at junctions and shall be bedded solid in pigmented 3:1 mortar.

Unless otherwise specified, verge tiles shall be used, neatly finished and secured as before described.

- a) For hips at steep pitches above 40°, hoop iron shall be used and fixed to the hiptree with two screws
- b) or nails to support the first hip tile.

### **13.4 Roofing Slates**

Roofing slates shall be from an approved quarry, free from cracks, veins, patches and other defects, squared up and dressed to the size specified and holed or slotted as required for fixing. All slate shall be equal to the samples to be submitted to and approved by the Representative/Agent.

Unless otherwise specified, the slates shall be of variegated colours in the proportion of approximately 90% natural grey and 10% coloured.

Slates shall be laid "broken bond" and vertical joints between slates and the bottom edge of each course of slates shall range perfectly straight. Slates shall be laid to a lap of 75 mm and shall be double nailed with approved 40mm long Grade 304 stainless steel nails.

Half slates shall be provided as required at abutments and at verges of roofs and a double course of slates shall



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be provided at eaves.

Slates shall be carefully cut and dressed close to the ridge and, where necessary, at abutments etc. and cut and close mitred at hips and valleys.

Where slates vary in thickness they shall be sorted on site and used in such manner that all slates in each course are of the same thickness with the thickness being gradually reduced in each successive course towards the ridge.

Hips and ridges shall be made watertight with approved soakers fixed under the slates in an approved manner.

**Note :** Slate roofing that relies solely on the provision of a waterproofing membrane for watertightness is not acceptable.

### 13.5 Fibre Cement Roofing Slates

Roofing slates shall be manufactured from fibre cement of grey or other approved colour and shall be free from cracks and other defects, holed as required for fixing and fixed in strict accordance with the Manufacturer's instructions.

Slates shall be laid in a staggered pattern with vertical joints between slates approximately 6mm wide and the vertical line shall range perfectly straight from eaves to ridge. Slates shall be laid to a lap of 110mm and shall be double-nailed with approved 40mm long Grade 304 stainless steel or copper clout nails. The lower end of each slate to be fixed with a copper discrivet.

Half slates shall be provided as required at abutments and at verges of roofs with a double course of slates provided at eaves.

Slates shall be carefully cut close to the ridges and, where necessary, at abutments etc. and cut and close mitred at hips and valleys.

Hips and ridges shall be made watertight with approved soakers fixed under the slates in an approved manner.

Where "Boston" hips are employed a 380mm wide continuous soaker of bitumen impregnated felt or 375 micron plastic damp-proof course shall be placed centrally over the full length of hips. Standard slates, halved longitudinally, are to be fixed in accordance with the Manufacturer's specification.

### 13.6 Roofing Sheets (Metal)

#### 13.6.1 General

Profiled metal sheet roof coverings shall comply with the following minimum requirements:

- a) Galvanised metal roof sheets shall have a minimum thickness of 0,8mm for roofs of 4° — 14° pitch inclusive and 0,6mm for roof pitches of 15° and upwards.



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Where any profile requires the use of steel manufactured in accordance with ASTM 446, Grade E, such steel shall be 0,5mm thick for all pitches.

**Note :** All steel which is claimed to comply with ASTM 446, Grade E, shall be supplied complete with a certificate of such compliance issued by the Manufacturer.

- b) Roof trusses shall be spaced at not exceeding 1,2m centres, except where the pitch is 12° or less, when the spacing may not exceed 1m centres.
- c) Purlins shall be spaced at not exceeding 1,0m centres for roof pitches of 4° to 30° inclusive and at 1,2m maximum for roofs having pitches of 31° and greater. Purlin spacings for flat metal roofs are to be as specified in Clause 12.9.
- d) Unless otherwise specified in this section, profiled metal roofing sheets shall be used and fixed all in accordance with SANS Code of Practice 0237.
- e) Roofing sheets for use inland shall have galvanised coating of Z275 quality.
- f) Galvanised roofing sheets for use in coastal areas shall be finished with an approved factory applied paint coating.
- g) All necessary cutting of sheets shall be properly performed. Cut edges at sides of valleys and where otherwise exposed shall be perfectly straight.
- h) Drive screws will not be permitted. The sheeting shall be drilled and not punched for fixing screws. Only special wood screws with proper thread will be permitted in conjunction with neoprene and metal washers.
- i) Hook bolt type fasteners shall each be provided with neoprene and metal washers under nut.
- j) Metal covered roofs having a pitch of 4° or less shall be as later specified for flat metal roofs in Clause 12.9. The provision and use of protective roof boards is compulsory.
- k) The Contractor is to submit a certificate, signed by the Merchant, stating that the galvanised roof covering supplied complies with the required thickness specified.
- l) Roof sheets shall be in single lengths to each slope of roof or to both roof slopes where a ridge is to be formed by bending the sheets over the ridge.
- m) The use of any approved factory applied paint finish shall in all cases be in



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addition to the galvanised coating as specified.

### 13.6.2 Profiles

#### a) Corrugated roofing sheets:

Corrugated galvanised iron roofing sheets shall comply with SANS Specification 934 with corrugations 17,5mm deep at 76mm centres giving an effective width of approximately 610 or 762mm between the crests of the outermost corrugations respectively, all coated with zinc having a mass of not less than that indicated in the following table for the three classes of galvanising specified:

| g/m <sup>2</sup> of surface area |            |
|----------------------------------|------------|
| Average                          | Individual |
| 600                              | 510        |
| 450                              | 385        |
| 275                              | 235        |

At exposed verges of roofs the iron shall be finished with neatly formed rolls. The sheets shall have side laps of not less than one and a half corrugations. The minimum end laps for the different roof slopes shall be in accordance with the following table:

| Slope of roof       | End lap (mm) |
|---------------------|--------------|
| greater 30° 25° 20° | 150          |
| less                | 175          |
|                     | 200          |
|                     | 225          |
|                     | 300          |

#### b) Rib-trough roof sheeting:

Rib-trough roofing sheets shall be pressed to troughed profile with ribs not less than 50mm deep at not exceeding 275 mm centres or with ribs not less than 28 mm deep at not exceeding 190 mm centres.

The sheets shall be lapped one rib at sides and fitted with approved sealing strips as supplied by the Manufacturer of the sheeting and fixed at each alternate rib to every purlin. The fixing of roof sheeting shall be as previously specified under Subclause 12.6.1.

#### c) Interlocking rib-trough roof sheeting with concealed fixing:



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Interlocking roofing sheets shall be of mild steel, coated with zinc having a mass of not less than that specified in the table under Sub-clause 12.6.2 (a) and comply with SANS Specification 563.

The ribs of the profile shall be not less than 40 mm deep for both the plain centre rib and the female clip-over rib. The male clip-in rib shall be not less than 38 mm deep, formed to accommodate the fixing clips and with a capillary action break.

The male rib will also be provided with a vertical section to give strength to the sheet with a water channel profile along the lower outer edge.

Ribs shall not exceed 180 mm centres with a beading rolled into bottom of trough to enhance the strength of sheets.

The sheets shall be cold rolled profiled on site in single lengths to each roof slope.

A galvanised flat iron starter strip of at least 1 mm thick as supplied by the Manufacturer shall be provided and properly nailed at each intersection with wooden purlins using nails of suitable length and diameter. The first sheet shall be clipped over the starter strip and secured thereto with self-tapping screws of suitable length and diameter at approximately 500mm centres.

Sheeting is to be laid in the direction of the prevailing winds, wherever possible, all fixed to each purlin with clips supplied by the Manufacturer. All fixing clips shall be of at least 0,8 mm thick galvanised flat iron, nailed to wooden purlins with two nails, each 50 mm in length, or be screwed to mild steel purlins with two self-tapping screws.

All sheets must be secured at both top and bottom ends by means of self-tapping screws passed through overhang on fixing clips into male section overhang at edges of sheets.

Bottom ends of troughs are to be bent down to form drips at gutter and bent at ridges to prevent backflow of water using an approved tool.

**Note :** Notwithstanding anything to the contrary, the spacing of purlins for interlocking rib- trough roofing sheets, measured centre to centre for any roof slope, shall be 1,9 m maximum.

d) Standing seam roofing sheets:

Standing seam roofing sheets shall be of galvanised steel, pressed to shape, with plain, trapezoidal or other profile standing seams on the upper side of the sheeting at not exceeding 250mm centres and with headings pressed into the sheeting between the standing seams to provide the necessary stiffness to the sheeting. The standing seams shall be of such shape as will accommodate the fixing clips and those along sides of the sheets shall be male and female to interlock with adjacent sheets. The standing seams, including the male and female standing seams when interlocked, shall be not less than 32mm deep.

The sheets shall be fixed with clips which must hold the sheets securely in position without the sheets having to be holed in any way. Male standing seams shall if required be closed, where the clips occur, by means of a special tool to ensure both the proper seating of the clips and that the standing seams will slide in the clips to allow for



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the expansion and contraction of the sheets. Fix clips to wooden purlins with galvanised driving screws, at least 50mm long, through holes in the clips. Each clip shall be fixed to steel purlins with securing clips of required shape and size to suit the purlins, or with self- drilling and tapping screws.

Only after all sheets have been laid, the interlocked standing seams at sides of sheets shall if required be button punched by means of a special tool at approximately 175mm away from each side of fixing clip and intermediately at not exceeding 900mm centres and also near ends of the standing seams.

The fixing of the roof covering shall be carried out in strict accordance with the manufacturer's instructions by a firm specialising in the fixing of this type of roof covering.

No end laps and no perforations for fixing screws will be allowed.

e) Aluminium roofing sheets:

Aluminium roofing sheets shall comply with the requirements of SANS Specification 903, and be of corrugated or rib-trough profile and thickness specified.

Sheets shall be in single length to each roof slope. Corrugated sheets shall be lapped not less than one and a half corrugations and rib-trough sheets one rib at sides.

Sheets shall be fixed to purlins as previously specified for corrugated and rib-trough mild steel sheets. Screw and hook bolts shall be of aluminium fitted with bituminous felt underwashers and shaped aluminium overwashers. Side laps shall be bolted together through the crest of the ribs with 6mm aluminium seam bolts and nuts fitted with neoprene washers under heads and spaced at not exceeding 600mm centres.

Screws and bolt holes in sheets shall be drilled (not punched) and shall be 1,5mm larger than the diameter of the screws and bolts. Purlins shall be spaced at 1,0m centres maximum for all thicknesses of aluminium.

Surfaces of any steelwork in contact with aluminium roof covering shall be given two heavy coats of bituminous base aluminium paint.

The roof coverings shall, wherever possible, be kept clear of concrete, mortar, plaster and masonry but where this is not possible such surfaces, where in contact with the aluminium, shall be painted as before.

Roof boards shall be used by all workmen to avoid damage to the sheeting.

### 13.7 Insulation

Steel framed industrial buildings and the like without ceilings shall be insulated using an approved material having a reflective foil surface on both sides and having an acceptable reinforcing fibre.

Air bubble cushion type insulating material having one reflective foil side and one side coloured plastic is approved for this purpose.

### 13.8 Ridging (Metal)

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#### 13.8.1 **For corrugated roofing**

Galvanised iron ridging for ridges and hips of corrugated iron covered roofs shall be 0,60mm thick (after galvanising), coated with zinc of mass as specified for roofing iron in the table in Subclause 12.6.2 (a).

The ridging shall be 450mm girth with roll top and bent down edges, lapped 225mm at heading joints; cut, properly lapped and fitted at intersections of ridges, hips and valleys; and beaten into corrugations of roofing iron to close openings. Roll shall be closed at feet of hips and at gable ends.

Ridging shall be fixed with screws to wood purlins and hook bolts to steel purlins using washers under heads and nuts, all as described for fixing corrugated iron roofing, but spaced at not exceeding 300 mm centres.

#### 13.8.2 **For rib-trough roofing**

Galvanised iron ridging for roofs covered with rib-trough roofing sheets shall be as previously specified in Subclause 12.8.1, but without roll top; provided with serrated metal closers under the wings and approved poly-closers in troughs.

Ridging shall be fixed with screws to wood purlins and hook bolts to steel purlins with washers under heads and nuts respectively, all as described for fixing the roof sheeting and at the same spacings.

#### 13.8.3 **For interlocking rib-trough roof sheets with concealed fixing**

Galvanised iron ridging for ridges of roofs covered with interlocking rib-trough roofing sheets shall be as previously specified in Subclause 12.8.1, but without roll top; provided with serrated metal closers under wings according to profile and with approved poly-closers in troughs. Fixing shall be by means of screws through the outer edge of the clip-over section.

#### 13.8.4 **For standing seam roofing:**

Ridging for roofs covered with standing seam roofing sheets laid to a fall of more than 7° shall be as previously specified in Subclause 12.8.1, but without roll top, not less than 430mm girth, bent to suit angle of ridge and bent down at each side and notched for ribs by means of a special notching shear with male and female interlocked ends and fixed with lugs attached to the ridging and with strips riveted to the lugs and to underside of the roofing sheets.

For roofs laid to a fall of 7° the standing seam roofing sheets shall be in one length to both roof slopes and sheets shall be bent over the ridge. The sheets shall be laid and fixed on one roof slope, after which the standing seams of each sheet shall be cut vertically with a hack-saw from the top to a depth of approximately 12 mm and the sheet then bent over the ridge and fixed on the other roof slope. Rib caps of galvanised mild steel, approximately 75mm long, shall be fitted over the saw cuts in the standing seams and set in a suitable sealing compound.

All work shall be carried out in strict accordance with the Manufacturer's instructions by a firm specialising in this type of work.

#### 13.8.5 **For aluminium roofing**

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Ridging or ridges of roofs covered with aluminium roofing sheets shall be of aluminium complying with the requirements of SANS Specification 903 and of thickness specified. The ridging shall be without roll top and shall be not less than 400mm girth, bent to suit angle of ridge, provided with notched poly-closers and aluminium closers under each wing of same thickness as the ridging, with end laps of not less than 150mm and fixed with screws to wood purlins and hook bolts to steel purlins with washers under heads and nuts, all as described for fixing the roof covering and spaced at not exceeding 450mm centres.

### 13.9 Flat Metal Roofs

A flat metal roof is defined as a flat structure covered with profiled metal roofing sheets laid with a fall of between 0° and 4° maximum. The use of such roofs is restricted to relatively small outbuildings/roof areas where no other solution proves viable or possible.

The supporting structure shall be such that any permissible deflection of the covering and/or roof under the sustained load of snow or hail in susceptible areas and of heavy rain will not cause the roof to leak.

The profiled steel sheets shall be of an approved type in single lengths preferably using concealed fixing. Where conventional fixing screws are used, these are to be rendered permanently watertight by means of a profiled cover strip held securely in place with the manufacturer's fixing clips.

In all areas of the country subject to heavy thunderstorms and/or hail the principal of "the deeper the profile the better" is to be followed.

Side laps of profiled sheets are to be sealed by permanently welting with a machine or, be side stitched in accordance with the Manufacturer's instructions and sealed using a butyl rubber sealant strip or, are to be provided with an acceptable capillary action break formed as part of the edge profile.

Ends of troughs are to be bent down at an angle of 45° into the eaves gutters to prevent rain- water from running back along the underside of the sheets and entering the building. The bending down of each trough shall be carried out with the utmost care to avoid tearing the sheet using a tool designed for that purpose.

Purlins are to be spaced at 1,0 m centres maximum.

### 13.10 Roofing Sheets (Fibre Cement)

Corrugated fibre cement roofing sheets shall comply with the requirements of SANS Specification 685. The sheets shall be not less than 6mm thick with corrugations at 178mm centres, or shall be not less than 7mm thick with corrugations at 241mm centres, or shall be of other approved pattern as specified.

Fibre cement roof sheeting for use in coastal areas shall be purchased with an approved factory applied paint finish or may be painted on site prior to erection with paint approved by and in strict accordance with the instructions of the Manufacturer of the roof covering.

The sheets shall be laid with smooth surface on top, mitre-cut at corners as necessary, all secured to wood purlins with 7mm diameter galvanised drive screws not less than 114mm long and to steel purlins with 8mm



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diameter galvanised hook bolts, each provided with a plastic or felt washer and a galvanised steel cupped washer over the plastic or felt washer. Felt washers shall be of bituminous roofing felt as SANS Specification 92 Type 60.

Holes for fixing screws or bolts shall be drilled (not punched) and shall be 2,0mm larger than the diameter of screws and/or bolts.

The fixing screws and nuts on fixing bolts shall not be tightened more than is necessary for holding down the sheets and the proper seating of the washer over the corrugations so as to allow for slight movement between the sheets and the supporting structure. On no account shall sheets be deflected at the intermediate purlins.

The side laps of sheets shall be sheltered in the opposite direction to that of the prevailing wind wherever possible.

All necessary cutting to sheets shall be properly performed. Cut edges at sides of valleys and elsewhere where exposed shall be perfectly straight.

The minimum end laps of sheets and the spacing of purlins, unless otherwise specified, shall be in accordance with the following table:

| Slope of roof   | End lap (mm) | Purlin spacing (m0) |
|-----------------|--------------|---------------------|
| 26° and greater | 200          | 1,400               |
| 21° to 25°      | 250          | 1,400               |
| 15° to 20°      | 300          | 1,350               |

The Manufacturer's instructions regarding laying and fixing of sheets, including side laps, mitre of corners and spacing of screws or bolts shall be followed in all cases.

One month after fixing, the roof covering shall be thoroughly examined and any defects made good with loose screws or bolts tightened.

Roof boards shall be used by all workmen for safety and to avoid damage to the sheeting.

### **13.11 Ridging (Fibre Cement)**

#### **13.11.1 Adjustable type corrugated**

Adjustable fibre cement ridging with corrugated wings for ridges of corrugated fibre cement covered roofs shall be of the same manufacture as the roofing sheets, of not less than 6mm thick material and with collared end joints.

Width of wings shall be not less than 300 mm measured from the centre of roll.

The ridging shall be secured all as described for fixing corrugated fibre cement roofing.

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### 13.11.2 Plain

Adjustable plain fibre cement ridging for ridges and hips of corrugated fibre cement covered roofs shall be as described above for the corrugated type, but wings shall be plain and thereby suitable for use on ridges and hips. The ridging shall be fixed as described in Subclause 12.11.1.

The openings between the wings of ridging and corrugations in roofing sheets shall be filled with 5:1 cement mortar neatly finished.

### 13.12 Flashings (Fibre Cement)

Fibre cement sole flashings for horizontal top edges of roofs butting against vertical wall or other surfaces shall be of the same manufacture as the roofing sheets, of not less than 6mm thick material and with overlapping heading joints. The flashings shall be corrugated and extend not less than 300mm on to the roof sheeting, have plain upstands against the vertical surfaces and be flashed over with sheet metal as described in Subclause 12.17.2.

The manufacturer's instructions regarding fixing of the flashings, including spacing of screws or bolts, shall be strictly adhered to.

### 13.13 Galvanised Sheet Iron

Galvanised sheet iron shall be 0,60mm thick (after galvanising) and coated with zinc having a mass of not less than that indicated in the following table for the three classes of galvanising specified:

| Class          | g/m <sup>2</sup> of surface area |            |
|----------------|----------------------------------|------------|
|                | Average                          | Individual |
| Z600 Z450 Z275 | 600                              | 510        |
|                | 450                              | 385        |
|                | 275                              | 235        |

The galvanised sheet iron for inland use shall be of Class Z275 quality.

Corroded or otherwise defective sheets shall not be used. All nailing and screwing shall be done with galvanised iron nails and screws.

### 13.14 Linings To Valleys

Linings to valleys in roofs shall be of galvanised sheet iron or sheet copper as specified having 225mm laps at end joints and dressed up and on to purlins at each side of valleys in corrugated iron and fibre cement covered roofs, but for slate and tile covered roofs shall have each edge folded back as open bead. Linings shall be cut and properly fitted at top and bottom of valleys.



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### 13.15 Linings To Secret Gutters

Linings to secret gutters at raking intersections of slate and tile covered roofs with vertical wall and other surfaces, e.g. sides of chimney stacks, shall be of galvanised sheet iron or sheet copper as specified, turned up for at least 100mm against vertical surfaces and up and on to batten along outer edges, all properly dressed at bottom to discharge on to the tiles or into eaves gutter as required.

### 13.16 Soakers

Soakers to slate covered roofs shall be of galvanised sheet iron or sheet copper as specified, 450mm wide to closed valleys and 250mm wide to raking intersections of roofs with vertical wall and other surfaces and sides of chimney stacks, turned up 100 mm against vertical surfaces. Soakers shall be 75mm longer than the gauge of slate (i.e. distance from centre to centre of battens plus 75mm).

### 13.17 Flashings (Metal)

#### 13.17.1 Sole flashings

Sole flashings to the various types of roofs shall be as follows:

- a) To corrugated iron

Sole flashings to corrugated iron roofs, where butting against vertical wall or other surfaces and sides and front of chimney stacks, shall be of galvanised sheet iron, turned up for at least 100mm against vertical surfaces and close dressed for not less than 200mm on to top of the roofing iron.

- b) To corrugated fibre cement

Sole flashings at raking intersections of corrugated fibre cement roofs with vertical wall or other surfaces and sides of chimney stacks shall be of galvanised sheet iron or sheet copper as specified, turned up for at least 100 mm against vertical surfaces and close dressed on to the fibre cement and over the nearest full corrugation. Sole flashings along horizontal top edges of such roofs where butting against vertical surfaces and front of chimney stacks shall be of fibre cement as described in Clause 12.12.

- c) To slate roofs

Sole flashings to horizontal top edges of slate covered roofs where butting against vertical wall or other surfaces and to front of chimney stacks in such roofs shall be of galvanized sheet iron or sheet copper as specified, turned up for at least 100mm against vertical surfaces and close dressed not less than 200mm on to the slates.

- d) To tile roofs

Sole flashings to horizontal top edges of clay and concrete tile covered roofs where butting against vertical wall or other surfaces and to front of chimney stacks in such roofs shall be of sheet lead of a mass not less than 24 kg/m<sup>2</sup>, turned up for at least 100mm against vertical surfaces and close dressed not less than 200mm on to the tiles.

#### 13.17.2 Cover flashings



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Turned up edges of sole flashings, chimney and secret gutter linings, soakers, etc. including waterproofing turn-ups, shall be flashed over with cover flashings of galvanised sheet iron or sheet copper as specified, having upper edges bent and set not less than 25 mm deep into joints in the masonry and stepped as required at raking intersections.

Cover flashings of sheet metal, unless otherwise specified, shall be fixed with 75 mm long flashing nails with hook portion not less than 20 mm long and securely driven into the masonry joints at ends and intermediately at not exceeding 400 mm centres. The flashing nails must not be driven through the flashings, but over the bent top edge with hook portion holding the flashing in position.

Flashing nails to copper cover flashings shall be of copper. All flashings shall be properly lapped and made completely watertight.

### **13.18 Pipe Flashings**

#### **13.18.1 To metal sheet roofs:**

Cast iron, mild steel and copper pipes of 50mm or more in diameter shall be flashed where passing through galvanised profiled steel sheet covered roofs with 0,60mm thick galvanised sheet iron sole piece, holed for pipe and fitted with sleeve piece of similar sheet iron, riveted and soldered at joint with sole piece, clamped to pipe at top with 25 x 3mm galvanised mild steel band fixed with galvanised gutter bolt.

Sole piece shall be close dressed on to the roofing iron and secured where necessary with galvanised gutter bolts having lead washers under heads, V-cut at top edge, dressed into corrugations and soldered to roofing iron.

Mild steel and copper pipes under 50 mm diameter shall each be flashed where passing through sheet covered roofs with 0,60 mm thick galvanised sheet iron sleeve piece around pipe, heavily soldered to roofing iron and flashed over with conical cover of similar sheet iron, heavily soldered at joint and to pipe.

#### **13.18.2 To corrugated fibre cement roofs**

Cast iron, mild steel and copper pipes of all sizes shall be flashed where passing through corrugated fibre cement covered roofs with 24 kg/m<sup>2</sup> sheet lead sole piece, closely dressed into the corrugations and bedded in mastic along top edge, secured to roof covering as necessary with galvanised gutter bolts, holed for pipe and fitted with sleeve piece of similar sheet lead wiped on to sole piece. In the case of pipes 50mm and more in diameter the sleeve piece shall be clamped to pipe with 25 x 3mm galvanised mild steel band fixed with galvanised gutter bolt and in the case of pipes under 50mm diameter secured to pipe with copper wire.

#### **13.18.3 To tile and slate roofs**

Cast iron, mild steel and copper pipes of all sizes shall be flashed where passing through tile and slate covered roofs with 24 kg/m<sup>2</sup> sheet lead sole piece, dressed under and over the tiles or slates, holed for pipe and fitted with sleeve piece of similar sheet lead, wiped on to sole piece and clamped to pipes 50mm and more in diameter with band and secured to pipes under 50mm diameter with copper wire, all as described in Subclause 12.18.2.

### **13.19 Making Good**



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Roofs, gutters, valleys, flashings, etc. shall be carefully examined at completion of the work, any holes or other defects soldered up or otherwise made good and the whole left perfect and watertight.

## **14. CARPENTRY AND JOINERY**

### **14.1 Treatment of Timber**

Timber shall be treated in accordance with Government Gazette Notice No. R. 602 of 27 March 1986 and any amendments thereto in all areas defined in the aforementioned notice. Proof of treatment is to be lodged with the Representative/ Agent prior to the use of any timber in the service. The specific properties mark shall also be indicated on all treated timber in accordance with SANS Specification 1288.

### **14.2 Wood Preservative**

Where all timbers are not required to be treated in accordance with Clause 13.1 in the remaining areas of the country, floor and roof plates, sleeper bearers, floor joists, boards and ends of timbers built into walls shall be given two good brush coats of one of the undermentioned wood preservatives, which shall comply with all relevant requirements of the SANS Specification shown in brackets after the name of the preservative, viz:

- a) Metallic naphthenates (SANS Specification 38).
- b) Pentachlorophenol (SANS Specification 42).
- c) Pentachlorophenolzinc naphthenate (SANS Specification 565).
- d) Tributyltin Oxide-Lindane (SANS Specification 1388).

All timbers shall be coated with the preservative before being fixed in position. After application of the preservative, any freshly cut and/or exposed surfaces shall also receive two coats of preservative.

### **14.3 Wrought Faces**

Exposed woodwork shall be wrought to a smooth surface and properly sandpapered to remove all machine or other tool marks.

For each wrought face on structural timber an allowance will be made off the "nominal" or rough sawn dimensions specified or stated on the drawings, as follows:

- a) 2,5mm for "nominal" dimensions up to and including 75mm.
- b) 3,5mm for "nominal" dimensions over 75mm.

For each wrought face on softwood joinery timber an allowance will be made off the "nominal" dimensions specified or stated on the drawings as follows:

- a) 3mm for "nominal" dimensions up to and including 75mm.
- b) 5mm for "nominal" dimensions over 75mm.



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The above will be the nett allowances permitted off the "nominal" dimensions specified or stated on the drawings and will not be additional to the tolerances specified for rough sawn timbers.

**Note :** No allowance shall be made off the dimensions given for hardwood joinery. The dimensions given shall reflect the exact, finished sizes required.

#### **14.4 Angles of Wrought Woodwork**

Unless specified to be angle rounded, all exposed angles of wrought woodwork shall be arris rounded. The term "arris rounded" denotes that the angles shall be rounded off to approximately 3mm radius and sandpapered to a smooth surface.

Angles of wrought woodwork specified to be angle rounded shall be rounded off to 6mm radius, unless otherwise shown on the drawings, and shall include, in framed joinery, for scribed and mitred joints.

#### **14.5 Structural Timber**

Structural timber shall be of South African softwood (pine) complying with the requirements of SANS Specification 563 or 1245 as applicable and shall be of Grade 4 or better (Grade 6 for some components of bolted roof trusses), all marked as laid down in the relevant specifications.

In addition all timbers shall bear the full standardisation mark of the South African Bureau of Standards.

Structural timbers between 50mm and 65mm in width and between 38mm and 50mm in thickness shall be of South African softwood (pine) complying with the requirements of SANS Specification 653.

All timber, as far as practicable, must be ordered in the dimensions in which it will be used, and must not be sawn into smaller cross sectional sizes as this is a contravention of the grading rules as laid down in R651.

Wrought structural timber, or any part of a structural member where wrought, shall be free from any edges or other defects which will spoil the appearance of the timber.

The timber shall be in single lengths or in two or more lengths, jointed end-to-end by finger jointing with each length not less than 1m long.

Battens, bracing and purlins, jointed by means of nail plates, will be acceptable if they are manufactured in accordance and comply with the requirements of SANS Specifications 563 or 653 as applicable.

Finger jointed timber shall be manufactured in accordance with SANS Code of Practice 096. The joints in timbers used for general roof construction and other components, where the timbers will not be exposed externally, shall be glued with a Class 2 type adhesive whilst joints in timbers used for external timber structures shall be glued with a Class 1 type adhesive, both types complying with the requirements of SANS Specification 1349. The timbers shall be marked with the letter "FJ" in black for timbers where a Class 2 type adhesive is used and in red for timbers where a Class 1 type is used; the letters shall be at least 25mm high.

Timber not used immediately and required to be stored on site shall, at delivery, be properly stacked horizontally



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on timber bearers. The minimum height above ground level shall be 100mm and the spacing of the bearers shall be such as will prevent distortion of the timber. Each stack of timber shall be completely covered with waterproof materials and protected from the elements.

If the above conditions are not adhered to the Engineer reserves the right to have tests carried out by an independent institution and to table a report for consideration, all at the Contractor's expense.

#### **14.6 Dimensions of Sawn South African Softwood**

The tolerance by which "actual" dimensions may vary from the "nominal" dimensions specified or stated on the drawings for sawn South African structural softwood, shall be as laid down in SANS Specifications 563, 1245 and 653 where applicable.

#### **14.7 Structural Laminated Timber**

Structural glued laminated timber shall comply with the requirements of SANS 1460, be marked as laid down in the specification and bear the standardisation mark of the SABS. The timber shall be of—

- a) softwood or hardwood;
- b) the stress grade;
- c) the exposure category;
- d) dimensions; and
- e) of appearance and surface finish/treatment, all as specified.

In services having timbers treated against infestation by insect pests, treatment against pests, shall be as laid down in the specification for laminated timber.

Laminated fascia boards and barge boards are to be absolutely knot free and such timber must also comply with the requirements described in Clause 13.5.

#### **14.8 Lengths of Timbers and Methods of Jointing**

Plates, sleeper bearers, joists, purlins, battens, laths, slats, etc. shall be in single lengths, but where this is not possible the end joints will be formed as described below. The joining of plates, battens, etc. at junctions and angles shall also be formed as stated hereunder, viz:

- a) Plates:

Floor and roof plates shall be halved at joints, junctions and angles, all well spiked together.

- b) Sleeper bearers:

Sleeper bearers under floors shall be butt jointed over sleeper piers.

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c) Joists:

Floor joists shall be lapped at least 300 mm with joints positioned over sleeper bearers, all well spiked together.

d) Purlins:

Purlins shall be splay cut and spliced at joints using timber side plates of the same dimensions as purlins, not less than 600mm long and six times nailed with 100mm long 3,5mm diameter wire nails. Adjacent purlins shall not be jointed between or on the same rafters.

e) Battens, laths, slats, etc.:

Except where timbers are spliced together by means of nailplates, sawn battens, laths, slats, etc. shall be butt jointed at heading joints and angles. Wrought battens, laths, slats, etc. shall be splay cut at heading joints and mitred at angles over points of support. Adjacent tile battens shall not be jointed on the same rafter. (Not applicable in the case of nailplate-spliced timber).

#### 14.9 Bolted Roof Trusses

##### 14.9.1 Timber connectors

Timber connectors for strengthening the joints between timbers of bolted roof trusses shall be made up as laid down in the National Building Regulations, SANS 0400, and shall consist of approved shear plates of adequate size or steel splitting connectors, inserted in grooves cut in the timbers. The grooves shall be cut with a special grooving tool, as supplied by the

Manufacturer of the connectors, comprising cutter head and spindle for location in the boltholes. The joints shall then be assembled with connectors in position, the bolts inserted and tightened up.

Where connectors are used the bolts shall be M12 complete with 50mm diameter x 3,5mm thick washers under heads and nuts.

##### 14.9.2 Bracing

Approved bracing according to the detail drawings shall form part of the roof system.

#### 14.10 Pre-Fabricated Roof Trusses

Pre-fabricated timber roof trusses shall comply with the requirements of SANS 0163 and be constructed of South African pine as described in Clause 13.5 to the designs shown on the manufacturer's detail drawings. The timber shall be of cross-sectional dimensions shown, cut to correct lengths with ends square or at the required angle. Trusses shall be assembled in truss fabricating jigs with the truss having the proper camber, all tightly clamped together with joints secured using approved connector plates of galvanised steel sheet. Connector plates shall be pressed into the timber simultaneously from both sides of the truss with a hydraulic press

capable of exerting such pressure as will ensure complete penetration of the teeth into the timber. The connector



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plates shall be of such size as will ensure that the joints so made will adequately withstand the forces exerted on the joints.

In coastal areas connector plates in buildings without ceilings shall be painted with two coats of epoxy tar complying with SANS Specification 801 Type 2, or rust neutralising paint.

Approval of pre-fabricated roofing systems, whether measured as an alternative or not, shall be subject to the following requirements:

- a) The manufacturer of the pre-fabricated trusses shall hold a certificate of competence issued by the Institute for Timber Construction.
- b) A1 size detailed drawings shall be submitted by the Contractor to the Engineer at an early stage for approval.
- c) The drawings shall be signed by a practicing structural engineer registered as a Professional Engineer (Pr Eng) or Professional Technologist (Pr Tech Eng) with ECSA.
- d) In the case of systems buildings, approval shall be given with submission of the contract drawings on acceptance of the tender.

Where a pre-fabricated roofing system is offered as an alternative to the conventionally bolted trussed rafter system, the Contractor shall offer the Employer a reasonable cost saving.

The following minimum information shall be shown on the drawings:

- a) Details of the roof system with the position of the rafters and purlins indicated thereon as well as typical elevations.
- b) Bracing as recommended by the Institute for Timber Construction.
- c) Sizes and grading of the timber components.
- d) Truss sizes, e.g. height of ridge or angle of pitch.
- e) Plate sizes for every connection point. (Code numbers only are deemed insufficient.)
- f) Separate connection details for hip, valley and jack rafters.
- g) Maximum spacing for purlins and bracing to ceilings shall be according to Subclauses 12.6.1 and 12.6.2 and Clauses 12.9, and 12.10.
- h) The type of roof covering as well as the design load.

Over and above the supervision undertaken by the Engineer, the Truss Fabricator or his Design Engineer shall inspect the completed roof structure and issue a certificate of confirmation to that: "The roof structure(s) has (have) been erected in accordance with the Design Engineer's drawings, as accepted by the Engineer, and the



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relevant details given in the manual "THE ERECTION AND BRACING OF TIMBER ROOF TRUSSES" issued by the National Timber Research Institute and the Institute for Timber Construction."

Rates for pre-fabricated roof trusses shall be deemed to include the design thereof.

#### **14.11 Valleys in Roofs**

Valleys in roofs generally shall be formed with two 228 x 25mm sawn boards, treated in accordance with Clause 13.2, well spiked down to roof timbers with purlins or tiling battens, depending upon the roof covering to be used, fixed along outer edges.

#### **14.12 Chimney Gutters**

Gutters at back of chimney stacks, where stacks pass through roofs, shall be formed with 25mm thick sawn boarding, laid with proper falls and fixed on 75 x 38mm bearers nailed to roof timbers.

The boarding shall be carried 228mm up the roof slope and, where the roof is covered with either corrugated iron or corrugated fibre cement roof sheeting, shall have purlins fixed along top edges, but for slate and tile covered roofs shall have tilting fillets, as for eaves of roofs, fixed along top edges.

Provide 25mm thick sawn gusset pieces at ends of gutters as required.

#### **14.13 Secret Gutters**

Secret gutters at raking intersections formed between clay or concrete tile covered roofs and walls or sides of chimney stacks shall be 75mm wide formed with 25mm sawn boarding, all fixed on 75 x 38mm sawn bearers nailed to roof timbers and with a length of tile batten nailed along outer edge of the boarding and to ends of the abutting tile battens.

The gutters shall be raised at the lower ends to discharge on top of tiling or into eaves gutters. The upper-ends of secret gutters into which other gutters discharge from, i.e. horizontal gutters at back of stacks, other walling and the like, shall be continued up to the top edge of such horizontal gutters and be properly joined to same.

#### **14.14 Timbers Near Flues And Fireplaces**

No timbers shall be fixed nearer than 110mm to any smoke flue or the inside of any fireplace opening. Similarly wood plugs for fixing shall be kept at least 100 mm away from smoke flues and the inside of fireplace openings. In all cases there must be at least 110mm of masonry between timbers and flues and inside flues and inside of fireplace openings.

#### **14.15 Fixing of Wood (General)**

Woodwork shall be fixed to walls with hardened steel nails driven into the brickwork or to wood plugs driven into joints where necessary with wire nails. In no case shall fixing be spaced at more than 700mm centres. All nail heads shall be punched and filled in with approved matching filler.

Jamb linings and the like shall be fixed with steel nails as above or with wire nails to 75mm wide wood fixing



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slips. Each slip to be of thickness equal to width of mortar joints and of length equal to the thickness of wall or width of lining, all built into brick joints as the work proceeds and in such a manner as to permit nailing into cross grain only. Nailing into end grain is unacceptable.

On completion of the work no hammer marks shall be visible on the finished surface of any timber.

Where hardwood is to be fixed to walls all screw heads shall be sunk and pelleted.

Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs at not exceeding 700mm centres. Where items are described as "bolted", the bolts and holes have been given separately.

#### **14.16 Floor and Wall Plates**

Floor plates shall be 75 x 38mm and roof plates 100 x 38mm and shall comply with Clause 13.5. Intermediate floor plates traversing rooms shall be laid on sleeper walls spaced at not exceeding 1,5m centres.

**Note :** Refer to Clauses 9.4 and 9.11 for further information.

#### **14.17 Floor Joists and Bearers**

Floor joists shall be of 38 x 100mm timber which shall comply with Clause 12.5, of at least Grade 6, spaced at not exceeding 400mm centres and all well spiked to plates and bearers.

Floor bearers under floor joists shall be 75 x 150mm timber, of at least Grade 6, spaced at not exceeding 1,5m centres, built 100mm into walls at ends and resting on sleeper piers. The ends of bearers, where built into walls, shall be protected against dampness by covering the bottom edge, ends and sides with plastic sheeting as for damp-course, neatly dressed around the bearers for a distance of 150mm from each end.

#### **14.18 Battens and Purlins**

Battens and purlins shall be in accordance with SANS 653 if not exceeding 63mm wide x 50mm thick and in accordance with SANS 563 if exceeding 63mm wide x 50mm thick, securely nailed to roof timbers with 4mm diameter wire nails, having a length of at least twice the thickness of battens and 120mm for purlins, one nail for each intersection, at centres specified ranging perfectly straight and square to roof with butt joints at heading joints and angles and in the case of wrought battens splayed joints at heading joints and mitred joints at angles.

#### **14.19 Bolted Connections**

Joints between timbers of roof trusses shall be spiked and bolted together, with M12 steel bolts, complete with 50mm diameter x 3,5mm thick washer under each head and nut. No bolt hole shall occur within 50mm of a finger joint.

#### **14.20 Ceiling Joists**

The tie beams of roof trusses will serve as ceiling joists but 38 x 100mm sawn ceiling joists shall be provided at right angles to tie beams at walls and elsewhere where support for brandering is required.

The supporting timbers for brandering shall in no case be spaced further than 1m centres.

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Ceiling joists shall rest on and be spiked to roof plates wherever possible. Where fixed parallel to tie beams the joists shall be hung, at not exceeding 3m centres, with 50 x 38mm sawn hangers spiked to joists and to 38 x 75mm sawn runners fixed on top of tie beams, and where fixed at right angles to tie beams, shall be cut in between and well spiked to the tie beams.

All necessary trimming at chimney stacks and elsewhere as required shall be properly performed.

#### **14.21 Fascias and Barge Boards**

Fascias and barge boards, where prescribed, shall be of pressed fibre cement boards, of section described and in long lengths, butt jointed with 75mm wide galvanised steel plates four times bolted with galvanised bolts over joints or with standard aluminium jointing strips and bolts.

#### **14.22 Framed Joinery**

Where the word "framed" is used, it is to include for all mortice and tenon joints, dovetail joints, grooves, stop grooves, rebates, stop rebates, housings, notchings, etc. including housed ends of shelves, divisions, etc.

#### **14.23 Timber for Joinery**

##### **14.23.1 General**

ounter and other tops, where only one face will be visible, is to be of Semi-Clear Grade.

All joinery work shall be put in hand immediately the order has been given to commence work; or after the receipt of details, where such are to be supplied, and shall not be wedged or glued up until just before fixing in the building. Timber stored on the site shall be properly stacked on delivery and adequately protected against extreme weather and exposure to the sun, until required for use.

a) **Hardwood:**

Hardwood for joinery shall comply with the requirements of SANS 1099, and shall be of Clear Grade and free of sapwood.

b) **Softwood:**

Softwood for joinery shall comply with the requirements of SANS 1359 and shall be of Clear Grade.

##### **14.23.2 Joinery**

No framed joinery, except for stock framed doors, for services situated inland shall be manufactured in the humid coastal belt, and no framed joinery for the services situated in the coastal belt shall be manufactured inland. This applies to both purpose made and stock joinery.

All exposed softwood timber in joinery which is not to be painted shall be free from large, loose or dead knots, knot holes, checks, splints, wane or other defects, and in joinery which is to be painted shall be free from all defects other than those which can be filled or otherwise made good in such a way as will not impair the paint finish. All exposed hardwood joinery timber shall be free from all knots, knot holes, checks, splints or other defects.



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Purpose made joinery shall be manufactured strictly in accordance with detail drawings where these are provided.

Stock joinery shall be of the best quality.

Joinery shall not be primed until it has been inspected and approved.

Skirtings, picture rails and the like shall be in long lengths. Heading joints where necessary shall be splayed. Counter tops, table tops, drainers and the like shall be formed with wide boards, jointed with grooved, cross-tongued and glued joints or with grooved rebated and glued joints of approved type; cross tongues shall be stopped 25mm back from ends where ends are exposed to view. The boards shall be in single lengths to tops etc., but where this is not possible, the heading joints shall be staggered and jointed as above.

Skirtings, picture rails, angle moulds and headings of all kinds shall be close fitted, mitred or scribed at angles and securely fixed; skirtings, picture rails and the like shall be fixed with hardened steel nails driven into the brickwork or with other suitable nails to wall plugs spaced at not more than 700mm apart. Glazing beads and the like shall be mitred at angles and shall be fixed with panel pins.

Descriptions (prices) of joinery shall be deemed to include arris rounded angles, blocking and planting on.

**Note :** No visible hammer marks shall be permitted to spoil the appearance of finished surfaces.

#### **14.23.3     Hardboard**

Hardboard shall comply with the requirements of SANS 540 and be of thickness specified. Tempered hardboard shall comply with the requirements for tempered hardboard as laid down in the above specification.

All hardboard used for interior work, sheets exceeding 0,75m<sup>2</sup> in area and not permanently attached to a solid backing and all hardboard used for exterior work shall be prestretched before fixing by thoroughly wetting the boards with water and scrubbing the screen side with a stiff brush or broom until a dark chocolate colour is obtained. Stack the boards, screen side to screen side for a period of 12 to 24 hours and air-dry for 1 or 2 hours immediately prior to fixing.

Hardboard not fixed permanently in position such as linings to concrete formwork, will not require the above treatment.

#### **14.23.4     Batten board**

Batten board shall be 19mm thick manufactured with 17mm thick kiln dried South African pine timber core formed of laminations not exceeding 45 mm wide, faced both sides with 1,0mm veneer (after sanding) suitable for painting or clear finish, all complying with SANS 929, assembled under hydraulic-pressure with water resistant synthetic resin adhesives and sanded to a smooth finish.

#### **14.23.5     Composite board**

a)     Blockboard:

Blockboard suitable for painting shall be of 5 ply type and 22mm thick, manufactured with 17mm thick kiln dried



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South African pine core laminations not exceeding 34 mm wide, crossbanded on both sides with 1,5mm veneer and faced on both sides with 1,0mm veneer (after sanding), all in accordance with SANS 929.

Blockboard with decorative veneer suitable for staining, varnishing or oiling shall be of 5 ply type 22mm thick, manufactured with 17mm thick kiln dried South African pine core laminations not exceeding 34mm wide, crossbanded both sides with 2,0 m veneer and faced both sides with 0,5mm decorative veneer. Decorative veneer applied to one face only is to be balanced with 0,5mm veneer on reverse side, all in accordance with SANS 929.

Edge strips to blockboard shall be formed with 10mm thick strips to match the face veneer and to be the full thickness of the board.

b) Decorative laminated plastic-faced board:

Boards lined with approved high pressure decorative plastic laminate shall comply with SANS 1405 with laminate having a nominal thickness of 1,2mm glued on under pressure with waterproof synthetic resin adhesive.

Where rounded edges or splashbacks are required, post forming quality high pressure plastic laminate sheets are to be used. The radius must not be less than 15mm for heat controlled forming and the nominal thickness shall be reduced to 1mm.

Worktops are to be covered on underside with a high pressure laminate sheet, without a decorative face, as a balancing back.

c) Particle board:

(i) Exterior and flooring type:

Particle board for exterior and flooring use shall comply with the requirements of SANS 1300 and be of the thickness and exposure class specified.

(ii) Interior type:

Particle board for interior use shall comply with the requirements of SANS 1301 and be of the thickness and exposure class specified.

**14.23.6 Veneer to blockboard**

Unless otherwise described, all blockboard is to have veneer suitable for painting both sides.

**14.23.7 Matched veneer**

Where specified, hardwood veneers in all units are to be matched.

**14.24 Wooden Doors**

All stock wooden doors shall comply with the requirements of SANS 545 and bear the SABS mark.



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In addition all framed and ledged batten doors and combination doors, where battens are utilised, for exposed, external use shall only be of construction acceptable to the Department, i.e. mortice and tennon where the tennon is exposed on the outside edges of styles and where the tennon is wedged to form a dovetailed shape.

Framed and ledged batten doors where both faces of doors will be exposed to the elements and are specified to have paint finish shall be of hardwood as described in Clause 13.23, and 44mm thick hung on hardwood or pressed steel door frames.

Framed panel and glass doors, where fully protected from the weather, or for decorative internal use, shall be of hardwood, all as described in Clause 13.23, 44mm thick, and hung to hardwood door frames internally and externally.

**Note :** The middle rail/ledge in purpose made framed panel or glass doors shall be positioned at such a height that the fitting of a mortice lock will not require the destruction of any joint between rail/ledge and stiles.

Flush doors may be of the following constructions: solid laminated, chip core, semi-solid or hollow core as specified. Flush doors shall not be used as external doors.

All flush doors shall, unless otherwise specified, be 40mm thick and hung to pressed steel door frames internally.

Heavy duty flush panel doors shall be of solid laminated construction. Medium duty doors shall, depending upon the frequency of usage, be of at least semi-solid construction for light usage and of chip core construction for heavier usage.

**Note :** The Contractor shall provide the Engineer with full constructional details of all flush doors that he proposes to use for approval.

The performance rating stamp on doors shall not be removed or obliterated until inspected in the hung position and approved. Unless any door is designed for such, door furniture on large or oversize backplates may not be specified.

#### 14.25 Hanging of Doors

These requirements are all in addition to paragraph 3.4.4 of SANS 545.

All doors are to be hung in such a way that the completed door functions smoothly and perfectly.

The clearance gap between door and frame after hanging shall not exceed 2 mm (+0mm -1mm) at sides and head of door. The gap between meeting stiles of doors hung folding shall also comply with the foregoing.

The clearance gap between foot of door and floor may be increased to 6 mm (+0mm -3mm) to accommodate any minor unevenness in the floor surface. The foregoing is not applicable where floor springs are specified to be used.

Any door frame found to be distorted or out of plumb shall be reported to the Engineer before any door is hung to such frame. Failure in this regard will result in the Contractor being held liable for all rectification work at his own expense. The foregoing shall be rigorously enforced where the door as hung will not close and latch properly, especially if specified to be fitted with a door closer of wever type, or is a stable door.



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When hung, no strain upon the hinges shall be detectable due to hinge binding. Depending upon the hinges supplied with pressed steel door frames, the hanging edge of a door may be angled back slightly from the hinge face of the door to obviate such binding.

External doors shall be hung on brass hinges from which the hinge pin is not removable.

Any door that is too wide or tall to fit the door frame shall be reduced in size by removing material equally from each edge — removing material from one edge only to obtain a fit is unacceptable.

Mortice locks where specified are to be snugly fitted into the mortice with face plate flush with edge of door. In flush doors the mortice is to be deep enough to accept the lock, but must not penetrate through to the core of the door.

Lever handle door furniture is to be fixed with the backplate parallel to the edge of the door. Ensure that the handles of wever type function smoothly and do not bind.

Screws used for fixing of hinges shall be screwed into holes of suitable sizes.

In addition, prior to the final hanging of any unprotected external door, where such door opens to the outside of the building, both the top and bottom concealed edges shall be sealed with not less than two coats of the finish specified for the exposed surfaces of the door. Where the door opens to the inside of the building only the bottom edge of the door shall be so finished.

#### **14.26 Set Up in Position for Building in of Timber Frames**

Timber frames to doors, windows, etc. shall be set up in position for building in as described in Clauses 9.4 and 9.12 respectively.

The jambs of timber door frames and similar frames, where a sill is not required, shall be dowelled to the threshold with 10mm diameter mild steel dowels, 75mm long, one to each jamb.

#### **14.27 Access Doors in Firewalls**

Access doors to firewalls in roofs shall be purpose made Class "D" fire doors complying with SANS 1253.

#### **14.28 Cleaning Out Etc.**

All shavings, cuttings and rubbish shall be cleaned out as it accumulates during the progress of the work. Care shall be taken that no debris is left under suspended timber floors.

Before giving up possession, the Contractor must ensure that all doors, windows, casements, etc. work easily, make any necessary adjustments and leave the whole of the work complete and perfect to the satisfaction of the Engineer.

### **15. CEILINGS, PARTITIONS AND ACCESS FLOORING**

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## 15.1 Brandering to Ceilings

Branderling not exceeding 65mm in width shall be of South African softwood complying with the requirements of SANS 653. Branderling exceeding 65mm in width shall be in accordance with SANS 563. All brandering shall bear the standardisation mark of the South African Bureau of Standards.

The brandering shall be securely spiked up to the supporting timbers with 90mm wire nails. Cross brandering shall be cut in between the longitudinal brandering, all securely skew nailed to same with 90mm wire nails. The sizes and spacing of brandering for the various types of ceilings shall be as follows:

a) Gypsum plaster board:

Size 38 x 38mm, fixed parallel to the ceiling boards at centres not exceeding 450mm for 900mm wide boards and 600mm for 1200mm wide boards. In the other direction brandering shall be spaced at 450mm centres for both 900 and 1200mm wide boards. Branderling shall also be fixed around edges of ceilings where required for fixing cornices.

Size 38 x 38mm, at not exceeding 450mm centres in one direction at right angles to the supporting timbers where metal H-section jointing strips are to be used.

b) Gypsum plaster board with plaster finish:

Size 38 x 38mm, at not exceeding 400mm centres in one direction at right angles to the supporting timbers, and around edges of ceiling where required for fixing cornices.

c) Fibre board

Size 38 x 50mm, at all joints between ceiling boards where joints between the boards are close butted or do not exceed 6mm wide or size 38 x 76mm where joints between the boards exceed 6mm wide and elsewhere size 38 x 38mm, fixed parallel to the ceiling boards at not exceeding 450mm centres for 900mm wide boards or 400mm centres for 1200mm wide boards. Branderling in other direction shall be spaced at 900mm centres for both 900 and 1200mm wide boards. Branderling shall also be provided around edges of ceilings where required for fixing cornices.

d) Fibrous plaster board:

Size 38 x 38mm, spaced at not exceeding 380mm centres in one direction with 38 x 38mm double brandering at longitudinal joints between ceiling boards where access above the ceilings is available, 50 x 38mm single brandering at longitudinal joints where access above the ceilings is not available (i.e. where fixing of the ceiling boards is to be done entirely from the underside). The 50 x 38 mm single brandering shall be grooved, 25mm wide and 18mm deep, along the underside as key for the reinforcing plaster which shall be forced into the joints between ceiling boards and up into the grooves in the brandering. Branderling shall also be provided around edges of ceilings where required for fixing cornices.

## 15.2 Covering to Ceilings

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#### 15.2.1 **Gypsum plaster board**

Gypsum plaster board shall be 6,4mm thick gypsum board complying with the requirements of SANS 266.

The boards shall be nailed to the brandering with 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, spaced at not more than 100mm centres at edges of boards and 150 mm centres along the intermediate brandering.

Cover strips to joints in gypsum plaster board ceilings shall be of plaster board as for ceilings, 50mm wide, with smooth machined edges, neatly jointed and fixed with 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, spaced at not more than 150mm centres.

Where brandering has been installed at right angles to ceiling boards metal H-section jointing strips shall be the acceptable means of distinguishing joints between boards.

The ceiling boards shall be in 900 or 1200mm widths layed out and with fixing commencing at the centre line of the ceiling. Ceiling boards shall only be cut down the length to form infill panels against walls, where such panels shall not be less than 300mm wide and shall be in single lengths to the width of ceilings wherever possible.

#### 15.2.2 **Gypsum plaster board with plaster finish**

Gypsum plaster board ceilings with flush plaster finish shall be of gypsum plaster board as described in Subclause 14.2.1, but nails shall be spaced at not more than 100 mm centres along the lines of the brandering.

Joints between boards shall be covered with wire or self-adhesive strips of brown paper scrim tape, all in accordance with the Manufacturer's instructions.

For plaster finish to ceilings see Clause 14.10.

#### 15.2.3 **Fibre board**

Fibre board for ceilings shall be 13 mm thick insulation board complying with the requirements of SANS 540, having a density of not less than 400 kg/cubic metre.

The boards shall be nailed to the brandering with 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, spaced at not more than 100mm centres at edges of boards and 150mm centres along the intermediate brandering.

Before being fixed the boards shall be stood on edge, in the room in which they are to be used, in such a manner as will allow for the free circulation of air around all the boards, enabling each board to reach equilibrium with the atmospheric conditions in the room. The boards shall remain in this position for a minimum period of 24 hours.

#### 15.2.4 **Flush fibrous plaster boards**

Fibrous plaster board for ceilings shall be of approved manufacture and, unless otherwise specified, shall be 8mm thick.



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The boards shall be of sizes required to suit the area of ceilings, all nailed to the brandering with smooth surfaces exposed using 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, with heads flush with surface.

Where access above the ceilings is possible nails shall be spaced at approximately 380mm centres, additional fixing shall be provided using suspensory ties of twisted sisal and gypsum plaster, passed over the brandering and fixed to tops of boards with daubs of gypsum plaster. All joints between boards shall be reinforced with a mixture of sisal and gypsum of not less than 12mm thick spanning each joint for a width of at least 40mm on either side. This reinforcement shall be applied on top of the boards.

Where access above the ceilings is not possible (i.e. where fixing is to be done entirely from underside) the nails shall be spaced at not exceeding 225mm centres. Joints between boards shall be reinforced with sisal and gypsum as described above, the mixture being forced into the joints between the boards and up into grooves previously specified to be machined in the underside of the brandering as for Subclause 14.1 (e).

Gaps between ceiling boards and all visible nail holes shall be filled with a mixture of gypsum plaster and sisal, scraped flush and trowelled to a smooth surface.

Fibrous plaster board ceilings shall be erected in strict accordance with the manufacturer's instructions by experienced craftsmen.

### **15.3 Cove Cornices to Ceilings**

#### **15.3.1 Gypsum plaster board**

Gypsum plaster board cove cornices to ceilings shall comply with the requirements of SANS on 622 and shall be of 76 or 125mm girth as specified, all nailed through the ceiling boards to the brandering and to walls at not exceeding 300mm centres with 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, or fixed to walls with hardened steel nails driven into the brickwork with heads flush with surface.

Cornices shall be scribed at internal angles, mitred at external angles and shall be in long lengths with splayed heading joints where necessary.

Moulded plastic corner pieces, manufactured for use with gypsum plasterboard cornices, may be used to eliminate scribed and mitred joints.

Fixing of cornices by means of an appropriate adhesive is acceptable, but this method of fixing shall be carried out in strict accordance with the manufacturer's instructions.

#### **15.3.2 Fibrous plaster board**

Fibrous plaster board cove cornices to ceilings shall be of 100mm girth and of approved manufacture, nailed to the ceilings and to wall plugs at not exceeding 300 mm centres with 2mm diameter galvanised or cadmium plated clout headed nails, 40mm long, or fixed to walls with hardened steel nails driven into the brickwork with heads flush with surface.



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Cornices shall be scribed at internal angles, mitred at external angles and shall be in long lengths with splay cut heading joints where necessary.

All joints and nail holes in cornices shall be filled in and finished off flush and smooth as described for ceilings. Where access above ceilings is possible all joints shall be grouted from behind with a mixture of gypsum plaster and sisal; daubs of this mixture shall be placed at approximately 0,75m intervals between the back of all cornices and walls.

Cornices shall be fixed by experienced craftsmen.

#### **15.4 Trap Doors in Ceilings**

Openings for trap doors in ceilings shall be trimmed with 38 x 100mm timbers, all securely spiked to the supporting timbers. The framework for the trap door shall be formed out of 38 x 50mm softwood, properly spiked to supporting timbers and trimmers. The size of the opening shall be 650 x 650mm.

Trap doors shall be formed with a skeleton frame of brandering as for ceilings, covered on the underside with ceiling boards and hung on a pair of 75 mm steel butts. Soffits of trap doors shall be flush with soffit of ceiling when closed and flap back 180° on to top of the brandering when opened.

Closed trap doors shall rest on 50 x 19mm softwood fillets all around the opening, mitred at angles and securely fixed to the soffit of the ceiling.

Any trap door larger than 650 x 650mm shall be provided with brandering along the centre, securely spiked to the skeleton frame.

#### **15.5 Ceiling Insulation**

All ceiling insulation materials shall comply with SANS 1381.

Ceilings shall be insulated, where so specified or where indicated on drawings, with approved resin bonded glass fibre or rock mineral wool insulation, not less than 75mm thick, in blanket form manufactured for the insulation of ceilings and laid in single thickness. The insulation shall be cut to size to closely fit between walls, ceiling joists, rafters, etc. and laid over brandering, or insulation may be of an approved mechanically blown cellulose fibre insulation having a minimum thickness of 75mm.

### **16. FLOOR COVERINGS, WALL LININGS, ETC.**

#### **16.1 General**

The floors and skirting shall be protected from damage during the progress of any remaining work and at completion shall be cleaned and handed over in a perfect condition. The work shall be carried out by skilled workmen experienced in laying these types of floor finishes.

#### **16.2 Vinyl Floor Finishes and Skirting**

##### **16.2.1 Materials**



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Semi-flexible vinyl floor tiles shall comply with the requirements of SANS 581 and fully flexible vinyl (PVC) floor tiles and sheeting shall comply with the requirements of SANS 786, all 2mm thick unless otherwise specified.

Floor tiles shall be 300 x 300mm in size and of approved colour. Vinyl cove skirting shall be of approved manufacture and 70mm in height.

#### **16.2.2 Laying and fixing**

Vinyl sheeting and tiles and such like floor finishes shall be laid in strict accordance with the manufacturer's instructions on a perfectly dry and clean screeded surface. The adhesive shall be of the emulsion type such as bitumen, rubber bitumen or latex-resin, all as described in SANS Code of Practice 070. The floor finishes shall be rolled with a suitable roller to ensure complete adhesion of the material. The flooring shall be cut where required and neatly fitted against adjoining floors, thresholds, etc. Vinyl skirting shall be close fitted to floors and walls,

butted at heading joints, neatly mitred at internal angles and dressed round external angles, and fixed with adhesive as for flooring.

Sheet flooring shall be in standard widths with cut sheets at sides of floors against walls etc. as necessary.

The floors and skirting shall be protected from damage during the progress of any remaining work and at completion shall be cleaned and handed over in a perfect condition.

The work must be carried out by skilled workmen experienced in laying these types of floor finishes.

#### **16.2.3 Rates**

Rates for floor coverings and wall linings shall be deemed to include dressing around and into corners.

### **17. IRONMONGERY**

#### **17.1 Ironmongery**

All ironmongery shall be of the best quality and shall be approved prior to fixing. Articles shall be fixed with matching screws.

All locks to external doors shall be either 5-lever mortice locks or Yale locks, as specified. Locks to internal doors shall be 3-lever mortice locks unless otherwise specified.

No key shall pass a second lock unless master keyed.

Door handles shall be chrome finished unless otherwise specified.

#### **17.2 Fixing**

Ironmongery is to be taken as fixed to wood unless otherwise described.

Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs.



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All necessary preparation of pressed steel door frames for the fixing of ironmongery to the frames has been included with the pressed steel door frames.

All screws, nails, bolts, etc. required for completion of the work shall be supplied by the Contractor.

### **17.3 Brass Strips at Junctions of Floor Finishes**

At junction of different floor finishes with each other provide and build in 3 x 25mm brass strips with top edges flush with adjoining finishes.

### **17.4 Dowels and Mortices**

The stiles of wood door frames, and similar frames not having sills framed in, shall be dowelled to concrete, brick, stone and similar thresholds with 10mm diameter mild steel dowels, 75mm long, one to each stile.

## **18. PAINTING**

### **18.1 Preparatory Work For Painting**

#### **18.1.1 General**

All floors shall be swept clean, walls dusted down and surfaces not being painted (i.e. face brickwork, sills, floors and stained woodwork) covered and protected against spotting before any painting is carried out.

No sweeping or dusting shall be done whilst painting is in progress or whilst paint is still wet.

#### **18.1.2 On woodwork**

Woodwork being painted shall be well brushed down, knots treated with knotting and all surfaces primed, stopped with hard stopping and rubbed down to an even surface ready to receive the paint.

Woodwork being oiled or stained shall have all plaster stains, pencil marks and other surface discolorations/blemishes carefully removed, be stopped with tinted stopping and well rubbed down.

Painted woodwork being redecorated shall, if the paint film is firm and sound, be washed down, have all cracks, crevices and holes scraped out, primed, made good with hard stopping, faced up and rubbed down to an even surface ready to receive the new paint. If the old paint film has blistered or broken down, the old paint must be completely removed back to the bare surface by the use of a blow lamp or paint remover and the woodwork prepared as above.

Care must be taken when burning off old paint not -bo char or otherwise damage the woodwork. All paint removers used must be free from soda or other caustic substances.

Existing oiled hardwood being redecorated shall be thoroughly cleaned down, stopped with tinted stopping and rubbed down. Existing stained woodwork shall be cleaned, similarly stopped and rubbed down.

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### 18.1.3 On metalwork

All metal surfaces being painted, except for structural steelwork, shall be cleaned of all rust, scale and dirt, removed by scraping or with steel wire brushes. All oil and grease shall also be removed and a perfectly clean surface obtained. If necessary, the surface shall be degreased, immediately before application of the priming coat, by the use of a suitable solvent. Any salt deposits on the metal surfaces, as may occur in industrial and marine atmospheres, shall be removed by means of a suitable detergent and the surfaces thoroughly rinsed and allowed to dry.

New galvanised metal surfaces, which are to be painted, shall be cleaned down as above and given 1 coat of self-etching wash primer complying with the requirements of SANS 723.

Protective coatings on new galvanised metal surfaces, applied by the manufacturer to prevent storage stain and white rust, shall be completely removed by the use of a suitable cleaning agent and the surfaces thoroughly rinsed and allowed to dry before the surfaces are primed.

Existing painted metal surfaces being redecorated shall be thoroughly rubbed and cleaned down before repainting, but if the paint film has blistered or broken down, the paint shall be completely removed down to the bare metal.

After removing rust from metalwork those portions so affected shall be treated with an approved rust inhibitor or rust neutralising paint.

### 18.1.4 On plaster

All plastered wall, ceiling and such like surfaces being painted shall be filled, where necessary, with suitable stopping or patching plaster and the whole rubbed down ready to receive the finishings.

Existing plastered surfaces previously painted and being redecorated shall be washed down, filled as above, where necessary, spot primed and rubbed down ready to receive the new paint.

Existing plastered surfaces previously distempered and being redecorated shall have the old distemper completely removed by wetting and scraping the surfaces, filled as above, where necessary, and rubbed down ready to receive the new finish.

Existing plastered surfaces previously limewashed and being redecorated shall be wire brushed to remove loose, flaking or powdered limewash, filled as above where necessary, and left ready for new limewash. If a finish other than limewash is to be applied, the old limewash must be completely removed, the surfaces washed down, filled, where necessary, and left in a fit state to receive the new finish.

### 18.1.5 On boarded ceilings

Boarded ceilings, including cover strips and cornices, being painted shall be filled where necessary with suitable stopping. All nail heads in ceilings, cover strips and cornices being painted shall be primed with flat paint.

Existing ceilings being redecorated shall be prepared for new finish as described in Subclauses 18.1.2, 18.1.3 or

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18.1.4, whichever applies.

## 18.2 Surfaces to be Dry

All wall, ceiling and similar plastered surfaces shall be perfectly dry and in a fit state to receive paint finishes, before the application of any paint.

Special care is to be taken when the plaster is specified to be finished with oil based paints.

## 18.3 Paints Etc.

All materials for paintwork for which South African Bureau of Standards Specifications have been published shall comply with the requirements of such specifications and bear the standardisation mark of the South African Bureau of Standards on the container or packing.

Materials for paintwork for which no SANS Specification have been published shall be of brand and manufacture approved by the Engineer.

All materials for paintwork must be brought on to the site in unopened containers and no adulteration will be allowed.

Primers and undercoats for paintwork shall be as supplied by the manufacturer of the paint being used for the finishing coat.

Paints etc. shall be suitable for application on the surfaces on which they are to be applied and those used externally shall be of exterior quality.

If necessary, paints etc. shall be strained free from skins and similar impurities immediately before application.

The various primers, undercoats and paints shall comply with the requirements of the specifications quoted hereunder and shall be of the type or grade stated, viz:

- a) Primers
  - i) For wood

SANS 678. Type I shall be used on exterior woodwork and Type III on interior woodwork.

- ii) For metal:

DIP OR SPRAY APPLICATION (RED OXIDE ZINC CHROMATE)

For steel windows, doors, door frames and other articles normally dip or spray primed in the manufacturer's works: SANS 909.

BRUSH APPLICATION (ZINC PHOSPHATE):

For all metal surfaces primed on site and then painted: SANS 1319.

- iii) For structural steelwork:

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ZINC PHOSPHATE: SANS 1319 or, when specifically specified, RED LEAD: SANS 312, Type II,

Grade I as per Clause 18.7.

iv) For plaster:

Alkali resistant primer shall be as described in SANS 681 [see (b) "Undercoats" hereunder].

b) Undercoats

For all surfaces under HIGH GLOSS, OIL GLOSS, FLAT and EGGSHELL finishing paints; SANS 681, Type II.

c) Finishing paints:

i) High gloss enamel paint: SANS 630

ii) Oil gloss: SANS 631.

iii) Flat and eggshell: SANS 515.

iv) Emulsion paint (interior): SANS 633, Grade I.

v) Emulsion paint (exterior): SANS 634 Synthetic Polymer Base Type, but pure aery lie resin base for fibre cement surfaces.

vi) Aluminium paint: SANS 682, Grade II.

vii) Roof paint: Alkaline type SANS 683, Type B.

viii) Structural steel paint: SANS 684, Type B.

ix) Textured wall coatings, emulsion base, for interior and exterior use: SANS 1227.

d) Light sand textured emulsion base acrylic wall coating:

Finish on walls shall be Light Sand Textured Emulsion Base Acrylic Wall Coating complying with SANS 1227, Type II of colour and texture to the approval of the Engineer.

The finish shall be applied in two coats over a base/primer coat of Bonding Liquid if the surface is porous.

The material (all coats) shall be applied by an applicator approved by the manufacturer of the coating being used (or his agent) and shall be mixed and applied in strict accordance with the manufacturer's instructions.

Before, proceeding with the application of the coating, the Contractor shall furnish the Engineer with a certificate from the South African Bureau of Standards stating that material being used complies with SANS 1227 and he shall also furnish proof that the applicator has been approved by the manufacturer of the coating being used.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

e) Emulsion base wall coating:

Finish on walls shall be an Emulsion Base Coating complying with SANS 1227 and of colour and texture to the approval of the Engineer.

The finish shall be applied in three coats and the texture of the base and second coats shall be compatible with the texture of the finishing coat.

The material (all three coats) shall be applied by an applicator approved by the manufacturer of the coating being used (or his agent) and shall be mixed and applied in strict accordance with the manufacturer's instructions.

Before proceeding with the application of the coating the Contractor shall furnish the Engineer with a certificate from the South African Bureau of Standards stating that the material being used complies with SANS 1227 and he shall also furnish proof that the applicator has been approved by the manufacturer of the coating being used.

The Contractor is to arrange for a trial panel of not less than 1 m<sup>2</sup> to be done and approved by the Engineer before proceeding with the application.

The coating shall be given a final coat of clear liquid which will dry to a hard glossy surface.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

**Note :** The plaster is to contain NO LIME WHATSOEVER.

- f) Varnish
  - i) SABS 887, Type I with eggshell finish, but not for use externally.
  - ii) Exterior varnish/clear sealer:

Exterior quality varnish/sealer shall be clear when dry. It shall be suitable for universal application to bricks, cement blocks, pavers, cement floors, wood, slasto, metal, fibrecement, cork, etc., provided that the surface of such materials allows for proper adhesion.

The material shall be a water based acrylic product, non-toxic, non-inflammable and unaffected by ultra-violet rays. In addition, it shall also contain algaecides, fungicides and bactericides and be resistant to damage by termites and wood boring insects whilst retaining great flexibility.

Once cured, the material shall be highly resistant to staining by petrol, diesel fuel, oil, hot fat, wine, carbon black grease, chemicals and other substances; it shall not deteriorate, dissolve or wash out.

- g) Rust neutralising paint:

Rust neutralising paint shall be of water based type containing suitable chemicals for converting rust to iron phosphor.

The paint shall be capable of being used successfully as a finishing coat or as a primer under epoxy paints, vinyl, chlorinated rubbers, laquers and coal tars. It shall be suitable for painting on steelwork prior to welding and shall not cause the failure of such welds due to flaking and migration of the paint into the weld area. In addition, the paint shall be suitable for application on wet surfaces without permitting rust creep and/or underrusting of the metal surface.

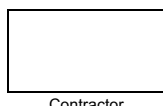
Preparation of rusted metal surfaces shall be limited to no more than wire brushing of such surfaces using power tools.

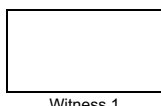
#### **18.4 Application of Paint Etc.**

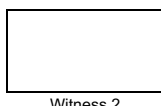
All coats of paint etc. shall be thoroughly dry and where necessary rubbed down before subsequent coats are applied.

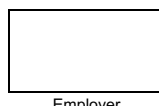
All work shall be finished to colour approved by the Engineer. The tints of undercoats shall approximate those of the finishing colour and in order to indicate the number of coats applied and to avoid misses when applying a succeeding coat a slight difference shall be made in the tint of each coat.

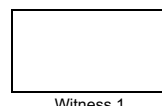
Priming on wood surfaces shall be by brush application only. Priming on surfaces other than wood shall be by brush application or, if it is the opinion of the Engineer that the primer and the surfaces are suitable for roller application, the primer may be so applied. Priming applied by brush shall be well worked in to obtain maximum penetration.

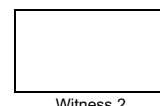
  
Contractor

  
Witness 1

  
Witness 2

  
Employer

  
Witness 1

  
Witness 2

Undercoat and finishing coats may be applied by brush or roller.

The use of a spray gun for on site application of paint will not be permitted, except in the case of cellulose and other special paints where spray painting is the accepted method of application.

Where spray painting is permitted all surrounding surfaces shall be properly masked.

The finishing coat on woodwork and metalwork shall be of high gloss paint, unless otherwise specified.

All materials shall be used in strict accordance with the manufacturer's instructions.

### **18.5 Priming**

Wood, metal, plaster and other surfaces normally primed before being painted shall be prepared and primed as before described in readiness to receive the specified paint system.

Backs of wood frames and other new or re-fixed joinery in contact with brickwork etc. and built in as the work proceeds shall be primed before building in, whether the articles are to be painted or not, to prevent moisture seeping into the wood from the mortar bedding.

Wood surfaces shall be knotted, primed and stopped before painting.

Tongued and grooved and rebated edges of boards in batten doors and other such like inaccessible parts of purpose-made joinery shall, before the joinery is assembled, be primed, or where the joinery is to receive a finish other than paint, be given 1 coat of such other finishing material.

Priming to external structural timbers shall be applied before the timbers are fixed in position and shall include all wrought surfaces such as backs of timber fascia and barge boards, sprocket ends, purlins, etc.,

### **18.6 Leave Perfect**

The Contractor shall provide all necessary dust sheets, covers, etc. and shall exercise all necessary care to prevent marking surfaces, walls, floors, glass, electrical fittings, etc. and shall keep all parts of the works perfectly clean and free at all times from spotting, accumulation of rubbish, debris or dirt arising from the operations. Any surface disfigured or otherwise damaged shall be completely renovated or replaced as necessary by the Contractor at his own expense to the Engineer's approval.

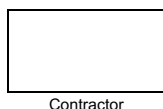
The premises shall be left clean and fit for occupation at completion of the work.

### **18.7 Corrosion Protection of Structural Steelwork (Portions enveloped by roof cladding, ceilings and other finishes included)**

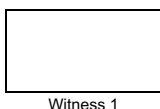
#### **18.7.1 Structural steelwork in coastal areas (within 10 km from coast)**

Structural steelwork is to be protected against corrosion as follows:

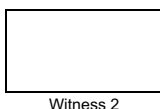
#### **a) Preparatory work**



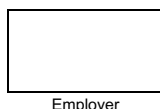
Contractor



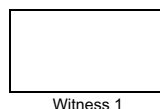
Witness 1



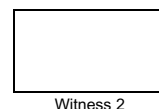
Witness 2



Employer



Witness 1



Witness 2

Steel to be cleaned down in accordance with SANS Code of Practice 064

All metal surface defects such as laminations and welding spatter shall be removed by grinding and sharp edges, rags, burrs, etc. shall be rounded off before cleaning. After fabrication, but before erection, all steel shall be abrasive blasted to a condition as shown under SA21/2 of Swedish Specification SIS 05 59 00—1967. The abrasive used shall be so selected as to give a surface profile not greater than 70 micrometers.

All steelwork so prepared is not to be touched by bare hands — linen gloves are to be worn. Before priming all abrasive must be removed by blowing down the structure with air or by means of an industrial vacuum cleaner.

b) Priming

Within four hours of abrasive blasting, apply, by air assisted airless spray, 1 coat of inorganic ethyl silicate zinc-rich primer to give a minimum dry film thickness of 70 micrometers.

The primed steel shall be allowed to dry sufficiently so as to limit damage due to handling.

After erection, the steelwork shall be washed down with clean fresh water to remove all deposited salts or corrosion products of the zinc (white rust) and allowed to dry.

Any damaged areas shall be made good by applying an organic zinc-rich primer that complies with SANS 926. (The application of inorganic zinc over inorganic zinc is not permitted.)

Allow the patch priming to dry before finishing. All traces of soluble salts and corrosive airborne contaminants shall be thoroughly removed with potable water and allowed to dry prior to finishing.

c) Finishing

After erection, apply, by airless spray or brush, two or more coats of high build chlorinated rubber or vinyl as required to give a total dry film thickness of at least 140 micrometers, followed by one layer of chlorinated rubber or vinyl top coat having a minimum dry film thickness of 30 micrometers.

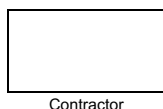
d) General

No surface preparation or painting shall be performed in adverse weather conditions.

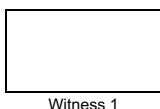
Edges are to be stripe painted before application of paint over the whole surface. Back to back sections and areas rendered inaccessible for painting after erection are to receive the full paint system before erection and fixing.

Drying times will be determined according to prevailing weather conditions and the manufacturer's recommendations.

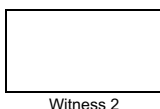
**18.7.2 Structural steelwork in inland areas**



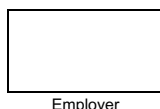
Contractor



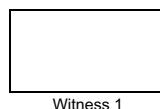
Witness 1



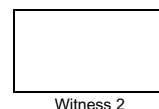
Witness 2



Employer



Witness 1



Witness 2

Structural steelwork is to be protected against corrosion as follows:

a) Preparatory work

Steel to be cleaned down in accordance with SANS Code of Practice 064.

All metal surface defects such as laminations and welding spatter shall be removed by grinding. Sharp edges, rags, burrs, etc. shall be rounded off before cleaning. After fabrication, but before erection, all steel surfaces to be scraped and wire brushed to Grade St 2 of Swedish Specification SIS 05 59 00-1967. Steelwork so prepared is not to be touched by bare hands - linen gloves are to be worn. Before priming, the surface shall be vacuum cleaned or dry brushed to remove all dust and debris.

b) Priming

As soon as possible after surface preparation, the first of two coats of red lead (SANS 312, Type 2, Grade 1) or zinc phosphate (SANS 1319) primer is to be applied. Each coat is to have a dry film thickness of at least 25 micron for red lead and 30 micron for zinc phosphate. A minimum of 24 hours are to be allowed between coats, or as recommended by the manufacturer. Any damage to the primer during handling or erection is to be repaired by removing any possible rust etc. and patch repaired to make up the original film thickness. All traces of soluble salts and corrosive airborne contaminants shall be thoroughly removed with potable water and allowed to dry prior to finishing.

c) Finishing

After erection, apply two coats of alkyd based structural steel paint complying with SANS 684, Type B, in accordance with the manufacturer's recommendations. Each coat is to have a minimum dry film thickness of 30 microns.

d) General

No surface preparation or painting is to be performed in adverse weather conditions.

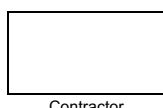
Edges are to be stripe painted before application of paint over the whole surface. Back to back sections and areas rendered inaccessible for painting after erection are to receive the full paint system before fixing and erection.

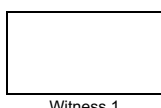
## 18.8 Rates

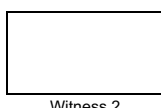
Rates for paintwork shall be deemed to include the preparation of surfaces including filling, stopping, sanding and priming of nail heads and screws.

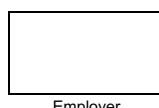
Rates for paint on pipes, gutters, etc. shall be deemed to include painting holderbats, hangers, clips, brackets, etc.

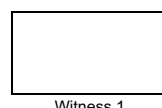
Rates for paint on windows, sashes, etc. shall be deemed to include priming the rebates of openings to be glazed.

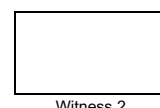
  
Contractor

  
Witness 1

  
Witness 2

  
Employer

  
Witness 1

  
Witness 2

## 18.9 Painting Windows and Doors (Applicable to Lump Sums Only)

Windows and doors specified to be painted shall be deemed to include painting such windows and doors on both sides and shall be for all coats specified i.e. primer, under coat and top coats.

## 19. MEASUREMENT AND PAYMENT

All items in this section will be measured by number, square meter or linear meter completed. The unit rates tendered in the Schedule of Quantities shall include for the supply of all materials, plant, equipment and labour necessary and for the building of all corners and the building in of all frames, pipe, anchors, etc. Areas of brickwork measured shall include lintels and air bricks unless listed separately in the Schedule of Quantities.

Where a lump sum is required for a completed structure, the tendered rate shall include all items and contingencies, as specified in this section or as shown on the drawings, and all other items or activities that can be reasonably expected by an experienced contractor.

### 19.1 Scheduled Items

#### 19.1.1 Brickwork ..... Unit : m<sup>2</sup>

Brickwork shall be measured on the centre line of the walls. Areas occupied in walls by windows and doors will be excluded from the areas measured and corners and intersections common to more than one wall will only be measured once.

The rate shall cover the cost of brickwork complete as specified, including test sections where specified, pointing, providing brick lintels, brick reinforcing and ties, the building in of conduits, beams, pipe sleeves, doors and windows, the raking out of joints and the filling of cavities and walls constructed of hollow concrete masonry units below floor level and elsewhere as specified or detailed on the drawings.

Different types of brickwork such as stock brick or face brick and different wall thicknesses shall be scheduled separately.

#### 19.1.2 Bagged finish to brickwork ..... Unit : m<sup>2</sup>

The rate shall cover the cost of providing rough sacking, additional cement grout as required and finishing the bagging as specified.

#### 19.1.3 Plaster work ..... Unit : m<sup>2</sup>

The rate shall cover the cost of the construction of the plaster work, the supply of all materials, mixing, applying, finishing, forming reveals, joints and corners, all complete as specified.

#### 19.1.4 Window sills

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2



- (a) External (described)..... Unit : m  
(b) Internal (described)..... Unit : m

The rate shall cover the cost of providing and building in the prescribed material for the window sills, including all cutting, wastage, fittings and accessories required or specified.

19.1.5 **Tiling** ..... Unit :  
m<sup>2</sup>

The rate shall cover the cost of providing the tiles specified, tiling adhesive and grout and any other materials required, preparation of surfaces, cutting and wastage and the laying, grouting and cleaning of the tiles complete as specified.

Wall and floor tiles shall be scheduled separately.

**19.1.6 Floor screeds**

- (a) Normal screeds..... Unit :  
m<sup>2</sup>  
(b) Granolithic screeds ..... Unit :  
m<sup>2</sup>

The rate shall cover the cost of the construction of the floor screeds, the supply of all materials, mixing, laying, finishing, forming nosings, readings, skirtings and the like, and where the concrete sub-floor has matured, the brushing and applying of a cement grout, all complete as specified.

19.1.7 **Paving** ..... Unit :  
m<sup>2</sup>

The rate shall cover the cost of providing the paving bricks, blocks or slabs specified, sand bedding and joint filling and expansion joint materials, plastic underlay and any other materials required, preparation of surfaces, cutting and wastage and the laying, grouting and cleaning of the paving complete as specified.

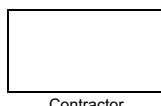
**19.1.8 Waterproofing**

- (a) Under walls ..... Unit : m  
(b) Under floors ..... Unit :  
m<sup>2</sup>

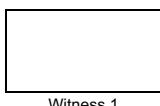
The unit measured for payment shall be the net length or area of waterproofing installed. Overlaps and turnups shall not be measured for payment.

19.1.9 **Expansion joints** ..... unit : m

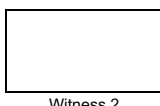
The rate shall cover the cost of providing and installing the joint specified, including all materials, plant and labour required. The length measured for payment will be the net length of joint constructed. Overlaps and wastage shall not be measured.



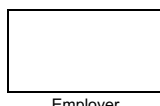
Contractor



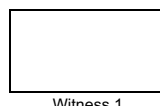
Witness 1



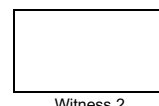
Witness 2



Employer



Witness 1



Witness 2

**19.1.10 Structural timber**

- (a) Wall plates (size indicated) ..... Unit : m
- (b) Beams (sized indicated)..... Unit : m
- (c) Joists (sized indicated)..... Unit : m
- (d) Rafters (sized indicated) ..... Unit : m
- (e) Purlins (size indicated ..... Unit : m
- (f) Brandering (size indicated) ..... Unit : m
- (g) Roof trusses complete ..... Unit :  
NoThe rate shall cover the cost of providing all materials, manufacturing, cutting, waste, laps, joints and fixing of the timber as indicated, including nails, bolts, washers, nuts, screws, hoop irons, ties and all other fixtures required, complete as specified.

**19.1.11 Roof covering**..... Unit : m<sup>2</sup>

Unless scheduled separately, the rate shall cover the cost of providing and fixing all roof covering material as specified, including all fixing materials, flashings, soakers, valleys, ridge covering and all other fixtures required to complete the work a specified.

**19.1.12 Fascias and barge boards** ..... Unit :  
m

The rate shall cover the cost of providing and fixing into place all materials, fixtures, screws, bolts, nuts, washers and other accessories required to complete the work as specified.

**19.1.13 Gutters and rainwater goods**

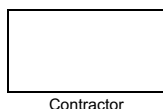
- (a) Gutters ..... Unit : m
- (b) Rainwater down pipes..... Unit :  
No

The rate for gutters shall include the cost of supplying and fixing all material including gutters, angles, stop ends, outlets, gutter brackets, jointing pieces, fasteners and all other items required to complete the work as specified.

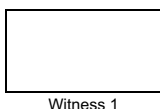
The rate for rainwater down pipes shall include the cost of supplying and fixing all material including down pipes, swan necks, jointing pieces, branch pieces, bends, outlet shoes, down pipe brackets, fasteners and all other items required to complete the work as specified.

**19.1.14 Ceilings**

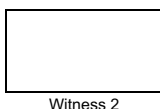
- (a) Ceilings ..... Unit :  
m<sup>2</sup>



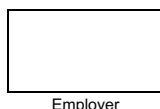
Contractor



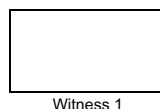
Witness 1



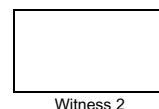
Witness 2



Employer



Witness 1



Witness 2

(b) Cornice to ceilings.....Unit : m

The rate shall cover the cost of supplying and installing all material including ceiling boards, cover strips to joints, nails or other fasteners, trapdoors and, where specified, gypsum plaster, complete as specified.

19.1.15 **Ceiling insulation** ..... Unit :  
m<sup>2</sup>

The rate shall cover the cost to supply and install the insulation specified.

**19.1.16 Joinery**

(a) Doors (type and size indicated)..... Unit :  
No

(b) Skirting (type and sized indicated) ..... Unit :  
m

(c) Other items (specified or indicated on the drawings) ..... Unit : No or  
m

The rate shall cover the cost of the supply of all material, manufacture, cutting, waste, fixing and installation of the prescribed joinery item, complete as specified.

The rate for doors shall cover of the door frame and all accessories, hinges, lock sets, handles, bolts, hooks, latches and the like.

19.1.17 **Metalwork** ..... Unit : No

The rate shall cover the cost of supplying all materials, manufacture, applying primer coat or galvanizing, as specified, delivery, building in of units, burglar proofing if specified, hinges, locks, handles, bolts, hooks, latches and the like.

**19.1.18 Resilient floor finishes**

(a) Vinyl-fibre, PVC or thermoplastic floor tiles (type and size indicated) ..... Unit :  
m<sup>2</sup>

(b) Vinyl cove skirting (type and sized indicated) ..... Unit : m

The rate shall cover the cost of supplying all materials and adhesives required and the laying of the floor finishes

19.1.19 **Other floor finishes**..... Unit :  
m<sup>2</sup>

The rate shall cover all materials and preparation work required and the laying, fixing or construction of the floor cover prescribed, all to the supplier's or manufacturer's specifications.

19.1.20 **Paint work** ..... Unit : m<sup>2</sup> or  
Sum

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Only the surface covered by the final finishing coat shall be measured for payment.

The rate shall cover the cost of surface preparation, supplying and applying the paint specified, repairing any damaged surfaces or defects and all materials necessary for completing the work.

19.1.21 **Electrical installation** ..... Unit : No or Sum

The rate shall cover the cost of supplying and installing and/or building in of all distribution boards, conduits, wiring, plug sockets and light switches, light fittings, junction and draw boxes and the like. The rate shall also cover the cost of chasing into walls, cutting recesses and holes in the walls and repairing any damaged surfaces after installation, testing of the installation and the provision of a Certificate of Compliance.

19.1.22 **Miscellaneous items** ..... Unit : No, Sum or m

The rate shall cover the supply, delivery, installation and where required, the testing, commissioning and putting into operation of the item scheduled, all materials, fastenings, painting, corrosion protection, tools, equipment and labour required to complete the scheduled item, as specified.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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## LEPELLE NORTHERN WATER

**CONTRACT No.: GTAC 006-2022-23**

**UPGRADE OF THE OLIFANTSPOORT AND EBENEZER WATER  
SUPPLY SCHEMES: REPLACEMENT OF PIPELINES AND  
REFURBISHMENT OF WATER TREATMENT WORKS**

**PORTION 2: CONTRACT**

**PART C4: SITE INFORMATION**

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PART C4: SITE INFORMATION

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

## C4.1 GEOTECHNICAL

A geotechnical investigation along the pipeline route was conducted. The geotechnical report with findings and recommendations is provided in **Annexure C.5.1**.

Tenderers must satisfy themselves as to the nature of materials to be excavated under this contract.

Tenderers are at liberty to excavate trial holes or to carry out other investigations to satisfy themselves as to the nature of the ground that will be encountered in carrying out the Works, provided that they advise the Engineer of their intention to carry out such trial hole excavations or other investigations so that the necessary safety requirements can be ensured. Any trial hole excavated in areas close to pedestrian or vehicular traffic shall be barricaded and shall be backfilled immediately after inspection of the soil conditions.

The Tenderer shall be fully liable for any claims for losses, damage or injuries whatsoever arising out of, or as a consequence of, carrying out trial hole excavations for the purpose of his tender. Furthermore, the Engineer's authority for the carrying out of any exploratory excavations is subject to the Tenderer indemnifying the Employer and the Engineer against any such claims.

## C4.2 ATMOSPHERIC AND CLIMATIC

The rainfall records from the nearest weather station at Polokwane, Rainfall Station No. 0677802BX, for the period 1992 to 2016 are reproduced in the Table below stipulating the monthly averages (Nn and Rn) for this period will be taken as the normal rainfall for the purposes of this Contract.

| MONTH       | (Rn)         | (Nn)        |
|-------------|--------------|-------------|
| January     | 82.2         | 11.3        |
| February    | 63.6         | 8.5         |
| March       | 58.9         | 8.5         |
| April       | 34.5         | 5.3         |
| May         | 10.3         | 2.3         |
| June        | 2.9          | 1.4         |
| July        | 2.7          | 1.5         |
| August      | 2.0          | 0.7         |
| September   | 4.8          | 2.4         |
| October     | 41.2         | 7.3         |
| November    | 95.8         | 12.1        |
| December    | 96.0         | 12.0        |
| <b>YEAR</b> | <b>494.9</b> | <b>73.3</b> |



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2



### C4.3 ENVIRONMENTAL

The studies done with regards to the EIA, site conditions and surrounding areas have been completed and will be made available to the contractor on the request.

The Environmental Management Plan, which is to be strictly adhered to during all activities involved in the performance of this Contract, is included in Document 1 of 2 under Section C1.2 Annexure E.

The purpose of the EMP is to ensure good management practices through planning and commitment with respect to environmental issues, and to provide rational and practical environmental guidelines to minimise disturbance of the natural environment.

The Contractor will be responsible for environmental control on site during construction and the maintenance period. The construction activities will be monitored by an independent environmental specialist and audited against the EMP.

### C4.4 INDUCTION

The Contractor and Sub-Contractors shall be responsible for acquainting themselves with and attending any safety induction courses presented at the applicable sites.

The Contractor shall supply the following documentation to the *Employer's Representative*, which will be sent to the relevant sites prior to induction:

- a) ID copies of all the personnel that will be working on site,
- b) Valid Letter of Good standing (COID certificate) from the Workman Compensation,
- c) All the signed appointment letters as per construction regulation, e.g., Safety Officer /Representative, etc.
- d) Signature of the Engineer or the Employer's Representative in charge of the contract,
- e) Initials on each page by the Contractor in charge of the Contract,
- f) Tool list,
- g) Candidates to be present for the Induction,
- h) Health and Safety plan and Environmental Management Plan
- i) Risk Assessment plan.

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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## LEPELLE NORTHERN WATER

### CONTRACT No.: GTAC 006-2022-23

#### UPGRADE OF THE OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMES: REPLACEMENT OF PIPELINES AND REFURBISHMENT OF WATER TREATMENT WORKS

#### PORTION 2: CONTRACT

#### PART C5: ANNEXURES

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

PART C5: ANNEXURES

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

# PART C5.1: GEOTECHNICAL INVESTIGATIONS

**C5.1 -1: SPECON PIPELINE REPLACEMENT PHASE 3**

**C5.1 -2: REHABILITATION OF MEGORING AND THAKGALANG RIVER CROSSINGS**

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

**C5.1 -1: SPECON PIPELINE REPLACEMENT PHASE 3**

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C5.1 -2: REHABILITATION OF MEGORING AND THAKGALANG RIVER  
CROSSINGS

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2