

TENDER DOCUMENT

FOR

**OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMES
UPGRADE: ELECTROMECHANICAL REFURBISHMENT OF
OLIFANTSPOORT PUMP STATIONS (PS1, PS2 & PS3)
AND EBENEZER WATER TREATMENT WORKS
AND PUMP STATION**

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

CLOSING DATE: 27 JUNE 2023

TENDER NUMBER: GTAC 003-2023-24 (Re-Advert)

CIDB GRADE 9 ME OR 9 EP

SUPPLY CHAIN

Government Technical Advisory Centre
(GTAC)
240 Madiba Street (corner Thabo
Sehume Street)
National Treasury Building
Pretoria, 0002

Contact Person:

Ms Nolubabalo Tokwe
Tel: (012) 315 5280
E-mail: psp@gtac.gov.za

EMPLOYER

Lepelle Norther Water
1 Landros Mare Street
Polokwane, 0700

Contact Person

Mr Gundo Motsoare
Tel: (015) 295 1800
E-mail: gundom@lepelle.co.za

NAME OF TENDERER : _____

Structure of Tender Document

Volume 1	<i>Book 1 of 2: Tendering Procedures and Contract</i>
	Book 2 of 2: Scope of Work, Technical Specifications and Site Information – This Document
Volume 2	Drawings and Details (issued separately)

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Volume 1 (Continued)

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Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

LEPELLE NORTHERN WATER

PROJECT REF NO.: GTAC 003-2023-23

**OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMES
UPGRADE: ELECTROMECHANICAL REFURBISHMENT OF
OLIFANTSPOORT PUMP STATIONS (PS1, PS2 & PS3)
AND EBENEZER WATER TREATMENT WORKS
AND PUMP STATION**

PORTION 2: CONTRACT

PART C3: SCOPE OF WORK

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.1 DESCRIPTION OF WORKS

C3.1.1 Employer's Objectives

C3.1.1.1. Objective of the works

The water supply to Polokwane and the environs has been severely constrained for over a decade, affecting the reliability of water services for human consumption and economic development of the area.

In response to the growing urgency to secure adequate and sustainable bulk water supplies required to address the current water shortages and long-term demands, Lepelle Northern Water (LNW) previously appointed MSW Engineering and Project Management Consultants (MSW) for the planning phase of the project to upgrade the Olifantspoort and Ebenezer Water Supply Schemes (O&E WSS). The results of the Feasibility Study, which was completed in 2017 and updated in 2022, formed the basis for the development of the Concept Designs for the refurbishments and upgrades of the bulk water supply infrastructure.

This Tender represents the first phase of the programme and is specifically aimed at stabilising the current LNW bulk water supplies by reducing water losses and improve operational efficiencies.

The proposed project involves the electromechanical refurbishment of the current pump stations (PS 1, 2 and 3) within the Olifantspoort Water Supply Scheme and Ebenezer Water Treatment Works and High Lift Pump Station within the Ebenezer Water Supply Scheme

The objective of the Employer is to appoint experienced Contractors for the execution of the project, installation, commissioning and performance testing of mechanical, electrical and instrumentation equipment, for the Works within stipulated time, performance and quality standards.

C3.1.1.2. Labour-intensive works

Labour-intensive works shall be constructed/maintained using local workers who are temporarily employed in terms of this Scope of Work.

C3.1.1.3. Labour-intensive competencies of supervisory and management staff

Contractors shall engage supervisory and management staff in labour-intensive works that have completed the skills programme including Foremen/Supervisors at NQF "National Certificate: Supervision of Mechanical/Electrical. Engineering Construction Processes" and Site Agent/Manager at NQF level 5 "Manage labour-intensive Construction Processes" or equivalent QCTO qualifications

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.1.2 Project Description

The Employer's objective is to appoint service provider(s)/contractor (s) in the fields of Civil, Mechanical, Electrical (Electronic & Heavy Current) Engineering for the purpose of implementing the Olifantspoort Pump Stations (PS 1, 2 and 3) and Ebenezer WTW and Ebenezer High Lift Pump Station Refurbishment Project. This includes the refurbishment of existing infrastructure, construction of new buildings, supply, installation, testing and commissioning of new electro mechanical infrastructure.

The Olifantspoort Water Treatment Works (WTW) is located at the Olifants River at about 80 km downstream of the Flag Boshielo Dam from where water is released before being abstracted at the Olifantspoort Weir. Water is pumped from Olifantspoort weir through a rising main to Olifantspoort Water Treatment Works which as a design capacity of 60MI/day.

The Olifantspoort WTW supplies potable water to Polokwane and to several Regional Water Schemes (RWS) along the way. Pumps Stations: PS1, PS2 and PS3 forms part of the bulk water conveyance infrastructure.

Pump Station 1 (PS1) pumps treated water from Olifantspoort WTW through a 26.3 km long 800mm diameter bulk pipeline to Specon Reservoirs, located in Lebowakgomo. PS1 is equipped with 5 pump sets (4 duty & 1 standby).

Water from Specon Reservoirs gravitates through a 790 mm diameter steel pipeline to Pump Station 2 (PS2) located approximately 6 km northeast of Specon Reservoirs. PS2 is equipped with 3 pump sets (2 duty & 1 standby) and feeds the Witkos Reservoir through a 17.5 km long 740mm diameter steel pumping main. PS2 is also equipped with a second set of pumps which supply the Bomplass settlement.

From Witkos reservoir there is 1.6 km long section of 740 mm diameter steel gravity main which feeds PS3 Pump Station located approximately 3 km north of Chuenespoort Dam along the R37 provincial road. PS3 is equipped with 3 pump sets (2 duty & 1 standby), and feeds the Palmietfontein Reservoir located in the vicinity of the Polokwane Smelter) via a 13.2 km long 740 mm diameter pumping main. Palmietfontein Reservoir supplies water to the Polokwane City service reservoirs via a 840 mm diameter steel gravity main, which after 8.3 km splits into two branches:

- 9.1 km long 740 mm diameter steel pipeline to Krugersburg reservoir complex,

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- 12.8 km long 690 mm diameter steel main discharging at Doornkraal reservoir, followed by section to Seshego reservoir and terminating at Perskebult reservoir.

One of the major strategic goals for LNW is to reduce water losses from its infrastructure to acceptable levels and to refurbish or replace all dysfunctional valves, pumps and electric motors, install variable speed drives, to improve operational and energy efficiency of all its pump stations.

C3.1.3 Scope of Works

C3.1.3.1 Overview

The contract provides the Employer's requirements for the refurbishment, replacement and repairs of different types of mechanical, electrical and electronic equipment at Olifantspoort Water Pumping Stations: PS1, PS2 and PS3, Ebenezer Water Treatment Works and High Lift Pump Station. This contract further includes construction of new buildings to house Variable Speed Drives at each of the pump stations.

The scope covers the requirements for the replacement of existing equipment with new equipment, stripping and assessment, redesign of weak features, general updating of design in accordance with modern design practice, repair, inspection, testing and certification of repaired equipment with the stipulated standards.

While this document contains quality control and assurance requirements, it does not cover all material and workmanship issues that shall be addressed by the Contractor and/ or Repairer through a duly certified ISO 9001:2008 Quality Management System. The Contractor shall have effective quality management system in place and be ISO 9001 approved. Furthermore, all activities will be done as per to the level of quality management stipulated therein and also taking into account input from LNW Management or Appointed Representatives, Risk Assurance & Management teams.

The Contractor shall provide qualified and competent teams with all the necessary equipment to provide the Service. The Contractor shall identify a representative as a key person approved, who will report to the Employer's or/and Engineer's Representative and co-ordinate all activities. The Site representative shall be a qualified, competent and an experienced person.

The parties responsible for design of the Works, unless otherwise specified, shall be as follows:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Element of the Works, or Stage of Design	Responsible Entity
Concept and feasibility	Employer
Basic engineering and layout up to tender stage	Employer
Civil works as per PS1.2.2	Employer
PS9 to PS10 - Mechanical and Electrical Works – Olifantspoort Pump Stations, Ebenezer Water Treatment Works and High Lift Pump Station (PS 1.3.2)	Contractor
Mechanical Works - Workshop drawings: structural steel	Contractor
Mechanical Works - Workshop drawings: miscellaneous items such as gratings, walkways, guardrails and ladders	Contractor
Electrical, Control and Instrumentation Works – Workshop drawings including wiring diagrams	Contractor

C3.1.3.2

C3.1.3.2.1 The Works – Olifantspoort Pump Stations: PS1, PS2 & PS3

The nature of works for this project includes, among others, the following activities:

- a) Site Establishment
- b) Site clearance
- c) Rehabilitation of access road to WTW/Pump Station 1 (see item C.3.1.6 below)
- d) Refurbishment works within the pump stations (PS 1, 2 and 3) inclusive of
 - i) Supply and install electronic pressure gauge (positioned after all throttling valves, and conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir. The successful bidder shall provide his own instantaneous flowmeter (possibly a clamp on ultrasonic meter) to do this test. The flow meter shall be mounted on the delivery side. Note: Pump duty (for new pump) may require adjustment on completion of this system curve verification exercise.
 - ii) Replacement of all high lift pumps and their associated valves and pipework. All suction and delivery site isolating valves to be electrically actuated
 - iii) Upgrade of all auxiliary mechanical systems including cooling water pumps (all pump stations), service water pumps (only in PS 1) and their associated pipe work and valves
 - iv) Maintenance and load testing of lifting equipment

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- v) Replacement of all high lift pump motors and installation of variable frequency/speed drives
- vi) Maintenance and testing of all high lift pump MV switchgear
- vii) Automation of the entire pump station including upgrading existing instrumentation PLC and HMI systems and SCADA systems
- viii) Upgrading of the telemetry systems
- ix) Replacement and installation of power and control cables
- x) Upgrading of low voltage boards and MCC panels
- xi) Minor pump station building modifications including painting, small power and lighting
- xii) Construction of VFD/VSD substation building to house new VFDs/VSDs
- xiii) Specialist MV protection studies; earthing and lightning protection studies
- e) OH&S
- f) Environmental Management
- g) Community Liaison

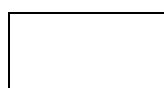
This scope of work includes all of the following works:

A. Mechanical and Electrical Works

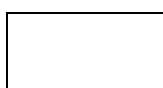
This portion of the Contract includes the following predominantly mechanical and electrical works defined as follows:

This portion of the Contract includes the mechanical and electrical equipping of the Olifantspoort Pump Stations which are collectively defined as Mechanical and Electrical Works. The Contract includes the following in respect of the Mechanical and Electrical Works for Pump Stations: the design, manufacture, supply, delivery, installation, testing, commissioning, training the Employer's staff in the operation and maintenance thereof, Trial Operation, and upholding during the Defects Notification Period. The Mechanical and Electrical Works for Pump Stations shall be designed to function safely and effectively in conjunction with the infrastructure in this Contract which is designed by the Employer.

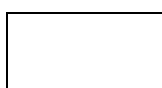
The principal features of the design works are described in the specifications, but these cannot indicate every detail necessary to meet the requirements of the Contract because the final design is the Contractor's responsibility. The Contractor shall complete the Works so as to achieve correct operation in a stable, reliable and fail-safe manner, to the approval of the Engineer.



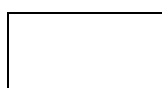
Contractor



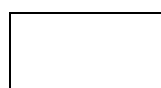
Witness 1



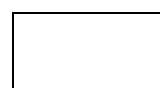
Witness 2



Employer



Witness 1



Witness 2

Tenderers shall include for all costs involved in carrying out the work described in design works, including programming to accomplish this work during the contract period in conjunction with the Contractor's other duties.

PS9 Engineering: The Mechanical and Electrical Works for Pump Stations, specifies this portion of the Works and associated detailed requirements, as well as references to other sections of C3: Scope of Works and Volume 5: Drawings where further requirements concerning the associated items of the Works are specified.

- (i). Olifantspoort Pump Station 1
- (ii). Olifantspoort Pump Station 2
- (iii). Olifantspoort Pump Station 3

B. Civil Works

This portion of the Contract includes the following civil construction work, defined as the Civil Works:

- Setting out of the Works
- The construction of a Variable Speed Drives Room
- Construction of reinforced concrete plinths for pumps and motors, and general civil repair works inside the pump station

C. General Works

In accordance with Sub-Clause 4.1.1 of the General Conditions of Contract, the Contractor is responsible for the following, applicable to the Mechanical, Electrical Works and Civil Works:

- Environmental management of the construction area during construction.
- Compliance with the requirements of the OHS Act and health and safety specifications.
- The liaison with the ward councillors of the local communities.
- All Temporary works required to construct the Permanent Works

C3.1.3.2.2 The Works Ebenezer Water Treatment Works and High Lift Pump Station

The nature of works for this project includes, among others, the following activities:

- h) Site Establishment
- i) Site clearance
- j) Water Treatment Works and High Lift Pump Station
 - i) Replacement of lime dosing system, refurbishment of polyelectrolyte dosing

Contractor

Witness 1

Witness 2

Employer

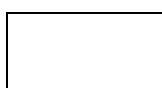
Witness 1

Witness 2

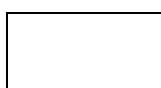
system, construction of rapid mix/flocculation channel, installation of actuators on filter valves, partial replacement of filter media, construction of a supernatant sump and pump station at the sludge dam, refurbishment of chlorine house

- ii) Upgrade of WTW control and instrumentation equipment including programmable logic controllers (PLCs), human machine interface unit (HMI), Remote IO cards, metering equipment and SCADA system
- iii) Replacement of all high lift pumps and their associated valves and pipework. All suction and delivery site isolating valves to be electrically actuated
- iv) Upgrade of all auxiliary mechanical systems including cooling water pumps (all Water Treatment Plant and High Lift Pump Station), service water pumps (only in the pump station) and their associated pipe work and valves
- v) Maintenance, refurbishment, and load testing of gantry
- vi) Replacement of all high lift pump motors and installation of variable frequency/speed drives
- vii) Automation of the entire pump station including upgrading existing control and instrumentation equipment including programmable logic controllers (PLCs), human machine interface unit (HMI), Remote IO cards, metering equipment and SCADA system
- viii) Upgrading of the telemetry systems
- ix) Replacement and installation of power and control cables
- x) Upgrading of low voltage boards and MCC panels
- xi) Minor pump station building modifications including painting, small power and lighting
- xii) Specialist MV protection studies; earthing and lightning protection studies
- xiii) Supply and installation of power and control cabling and cable supports.
- k) OH&S
- l) Environmental Management
- m) Community Liaison

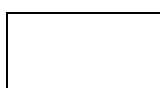
This Contract includes all of the following works only applicable to Ebenezer Water Treatment Plant and High Lift Pump Station, and Rustfontein Reservoir:



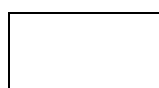
Contractor



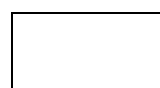
Witness 1



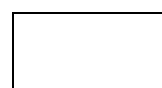
Witness 2



Employer



Witness 1



Witness 2

D. Mechanical and Electrical Works

This portion of the Contract includes the following predominantly mechanical and electrical works defined as follows:

- This portion of the Contract includes the mechanical and electrical equipping of the Ebenezer Water Treatment Plant and High Lift Pump Station which are collectively defined as Mechanical and Electrical Works. The Contract includes the following in respect of the Mechanical and Electrical Works for Water Treatment Plant and High Lift Pump Station: the design, manufacture, supply, delivery, installation, testing, commissioning, training the Employer's staff in the operation and maintenance thereof, Trial Operation, and upholding during the Defects Notification Period. The Mechanical and Electrical Works for Ebenezer Water Treatment Plant and High Lift Pump Station shall be designed to function safely and effectively in conjunction with the infrastructure in this Contract which is designed by the Employer.
- The principal features of the design works are described in the specifications, but these cannot indicate every detail necessary to meet the requirements of the Contract because the final design is the Contractor's responsibility. The Contractor shall complete the Works so as to achieve correct operation in a stable, reliable and fail-safe manner, to the approval of the Engineer.
- Tenderers shall include for all costs involved in carrying out the work described in design works, including programming to accomplish this work during the contract period in conjunction with the Contractor's other duties.
- PS9 Engineering: The Mechanical and Electrical Works for Water Treatment Plant and High Lift Pump Station, specifies this portion of the Works and associated detailed requirements, as well as references to other sections of C3: Scope of Works and Drawings where further requirements concerning the associated items of the Works are specified.
 - (i). Ebenezer Water Treatment Works
 - (ii). Ebenezer High Lift Pump Station
 - (iii). Rustfontein Reservoirs

E. Civil Works

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

This portion of the Contract includes the following civil construction work, defined as the Civil Works:

- Setting out of the Works
- Minor civil works and refurbishment of chlorine room, lime storage building,
- Construction of reinforced concrete plinths for pumps and motors, and general civil repair works inside the pump station
- Construction of Flocculation channel, Sump & Valve Chamber and Raising of filter walls
- Modification of Sludge Dam

F. General Works

In accordance with Sub-Clause 4.1.1 of the General Conditions of Contract, the Contractor is responsible for the following, applicable to the Mechanical, Electrical Works and Civil Works:

- Environmental management of the construction area during construction.
- Compliance with the requirements of the OHS Act and health and safety specifications.
- The liaison with the ward councillors of the local communities.
- All Temporary works required to construct the Permanent Works

C3.1.3.3 Temporary Works

The Contractor shall be responsible for selecting what Temporary Works are required including the design of concrete mixes, formwork and their compatibility with the permanent Works.

C3.1.3.4 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.1.3.3 Temporary Works

The Contractor shall be responsible for selecting what Temporary Works are required including the design of concrete mixes, formwork and their compatibility with the permanent Works.

C3.1.3.4 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.

C3.1.4 Location of Works

PS1.4.1 Location of Site – Olifantspoort Scheme

A. Olifantspoort Pump Station 1

Olifantspoort Pump Station 1 is located in Lebowakgomo within Lepelle-Nkumpi Local Municipality under Capricorn District Municipality of Limpopo Province. Pump Station 1 is situated at coordinates 24° 21' 17.06"S, 29° 45' 31.55 E approximately 50km East of Lebowakgomo.

B. Olifantspoort Pump Station 2

Olifantspoort Pump Station 2 is located in Lebowakgomo within Lepelle-Nkumpi Local Municipality under Capricorn District Municipality of Limpopo Province. This Pump Station 2 is located in an area which was previously known as at Rusplaatis which is situated at coordinates 24° 16' 31.09"S, 29° 32' 39.01"E approximately 1,7km from R518 Road within Lebowakgomo.

C. Olifantspoort Pump Station 3

Olifantspoort Pump Station 3 is located in Ga-Chuene Village/ within Polokwane Local Municipality under Capricorn District Municipality of Limpopo Province. This Pump Station 3 is located in an area which was previously known as De Gladdeklipkop now called Ga-Chuene are situated at coordinates 24° 08' 38.98"S, 29° 28' 51.75"E along R37 Road from Polokwane to Chuene Pass.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.1.4.2 Access to Site

A. Olifantspoort Pump Station 1

Olifantspoort Pump Station 1 is accessible from R37 road to Mashishini, on R37 immediately after crossing Chuene Pass drive approximately 2.5km then turn right to R518 towards Lebowakgomo leading Mamaolo Village. At Mamaolo Q4 Fuel Station then follow the map with direction as indicated below.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

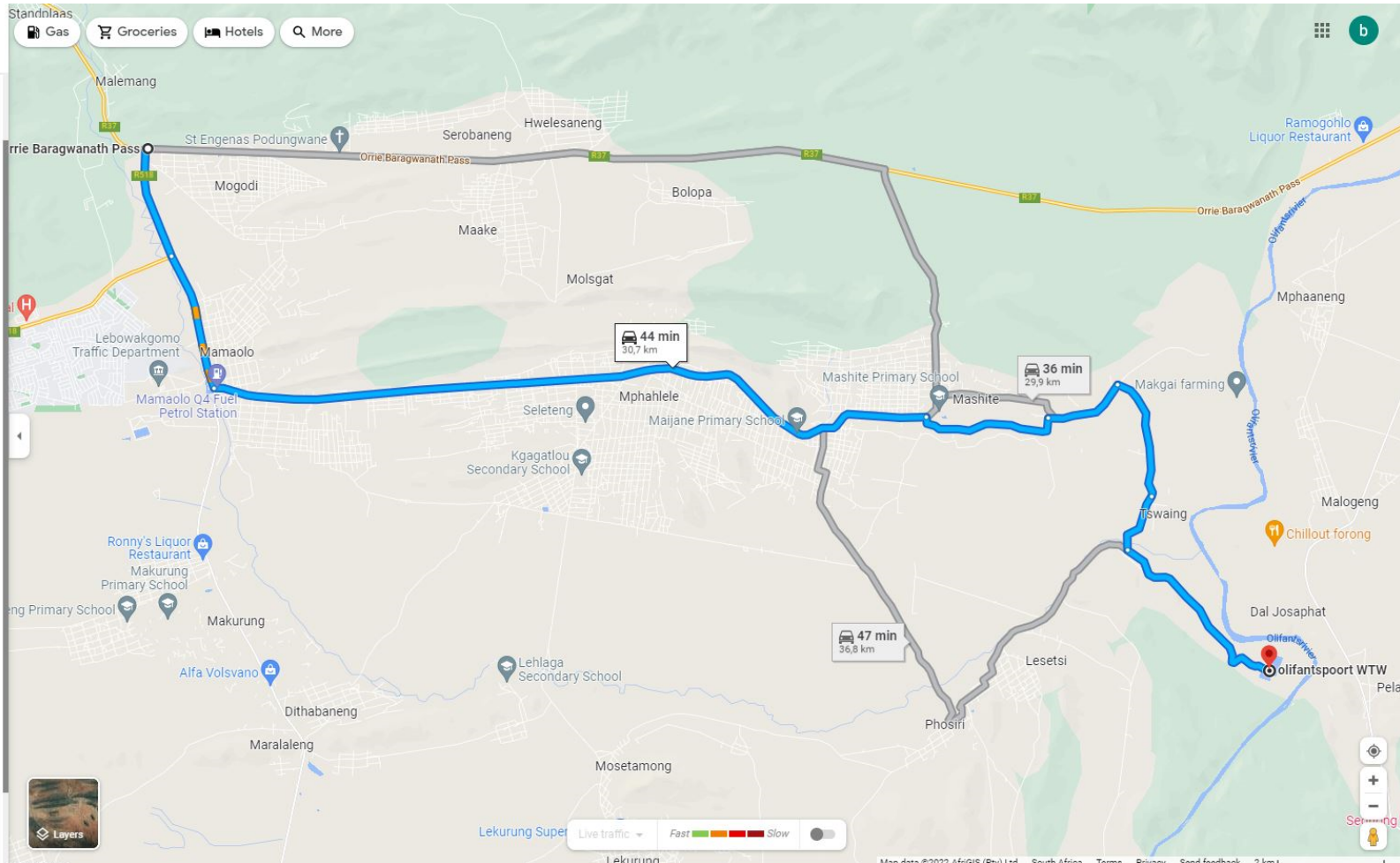
← from Orrie Baragwanath Pass
to olifantspoort WTW, Unnamed, Newlands, Pretor...

Orrie Baragwanath Pass

- ✓ Drive from Orrie Baragwanath Pass to Mamaolo
5 min (4.8 km)
 - ↑ Head west on Orrie Baragwanath Pass/R37 toward R518
51 m
 - ↩ Turn left onto Orrie Baragwanath Pass/R518
2.1 km
 - ↑ Continue straight
2.6 km
- ✓ Drive to your destination
44 min (25.9 km)
 - ↩ Turn left
14.1 km
 - ↪ Turn right
2.7 km
 - ↪ Turn right
1.6 km
 - ↪ Turn right
2.4 km
 - ↑ Continue straight
1.2 km
 - ↩ Turn left
3.9 km

olifantspoort WTW
Unnamed, Newlands, Pretoria, 0049

These directions are for planning purposes only. You may find that



Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

B. Olifantspoort Pump Station 2

Olifantspoort Pump Station 2 is easily accessible from R518 which is the road leading to Lebowa kgomo Hospital

D. Olifantspoort Pump Station 3

Olifantspoort Pump Station 3 is easily accessible from R37 which is from Polokwane to Chuene Pass. This Pump Station 3 is on R37 almost 14km away from Anglo American Polokwane Smelter.

C3.1.4.2. Location of Site and Access – Ebenezer Water Scheme

A. Ebenezer Water Treatment Works and High Lift Pump Station

The Ebenezer Water Treatment Works and High Lift Pump Station are located along the R 528 road towards Tzaneen downstream of the Ebenezer Dam within the Ebenezer Water Treatment Plant, Limpopo Province. Ebenezer dam is almost 70km away from Polokwane when driving through R71 then join R528.

GPS location: Latitude - 23°56'41.95"S, Longitude - 29°59'0.90"E

B. Rustfontein Reservoirs Complex

Rustfontein Reservoir complex is located along the R 528 road towards Tzaneen, Limpopo Province. Rustfontein Reservoirs complex is almost 55km away from Polokwane when driving through R71 then join R528, this means it's almost 15km from Ebenezer dam towards Polokwane when driving through R528.

GPS location: Latitude -23°56'13.78"S, Longitude - 29°54'7.61"E



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.2 ENGINEERING: DESIGN OF THE WORKS

C3.2.1 Design Responsibilities

The Contractor is required to undertake the entire detail design the Works and Performance after installation, commissioning and trial period operations:

- a) He shall do so in accordance with the Employer's Requirements as specified in Part C3: Scope of Work and as shown on the drawings provided by the Employer.
- b) He shall provide comprehensive design documentation to the Engineer for approval before commencing with procurement, construction or fabrication of that element or stage of the Works.

C3.2.2 Design by the Employer

C3.2.2.1 Drawings for Tender Stage

The design prepared by the Employer and the drawings included are provided for tendering purposes. The drawings must be regarded as provisional and preliminary for Tenderers to generally assess the extent of the Works.

C3.2.2.2 Drawings for Construction

Once the Contractor is given the instruction to commence the Works, the Engineer will deliver to the Contractor copies of the drawings for which the Employer is responsible for construction purposes and any instructions required for the commencement of the Works.

Further drawings will be issued to the Contractor in stages to allow the Contractor to undertake the construction in accordance with his approved program, and will not be available in entirety at commencement of the Works. From time to time thereafter during the progress of the Works, the Engineer will issue further drawings and details as may be necessary for adequate construction, completion and defects correction of the Works. The Works shall be carried out in accordance with the latest available revision of the drawings.

The Contractor shall maintain a register on the Site of all drawings and revisions thereof in the chronological order in which they are delivered to him.

All drawings and specifications and copies thereof remain the property of the Employer, and the Contractor shall return all drawings and copies thereof to the Employer at the completion of the Contract.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.2.2.3 Amendments and Details to Accommodate Mechanical and Electrical Works

The Contractor shall ensure that the overall size of the pumping pipework assembly is as per the tender drawings and fits into the existing pump station building.

If amendments to the Design by the Employer and associated drawings are required to accommodate the Mechanical and Electrical Works, the Contractor shall provide the necessary details (as specified elsewhere) in good time, to allow the Employer's designers adequate time to attend to the design amendments. No claims for extension of time and/or additional compensation will be considered or granted by the Engineer in connection with delays due to late issuing of design details and/or drawings, where such reasonable delay is a result of the Employer's designers having to amend designs and/or drawings to accommodate the Mechanical and Electrical Works.

C3.2.3 Design by the Contractor

C3.2.3.1 Contractor's General Design Obligations

Although the Engineer has specified the equipment to be provided for tendering purposes, the Contractor shall be responsible for the detail design of all proprietary Plant and Materials in order to ensure that these are appropriately selected for their intended use and installed to meet the particular installation conditions on Site. The Contractor shall submit the requisite shop drawings for approval by the employer prior to commencement of any construction works and the 'as-built' information and/or drawings including operation and maintenance manuals prior to the issuance of a Completion Certificate.

The Contractor shall carry out, and be responsible for, the design of the Works. Design shall be prepared by designers who:

- a) are engineers or other professionals, qualified, experienced and competent in the disciplines of the design for which they are responsible.
- b) comply with the criteria (if any) stated in the Employer's Requirements; and
- c) are qualified and entitled under applicable Laws to design the Works.

Unless otherwise stated in the Employer's Requirements, the Contractor shall submit to the Engineer for consent the name, address, detailed particulars and relevant experience of each proposed designer/design Subcontractor.

The Contractor warrants that the Contractor, the Contractor's designers and design Subcontractors have the experience, capability and competence necessary for the design. The Contractor undertakes that the designers and design Subcontractors shall be available to attend discussions with the Engineer and/or the Employer at all reasonable times (on or off the Site), until the issue of the Performance Certificate.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Promptly after receiving a Notice under Sub-Clause PS 3.3 [*Commencement of Works*], the Contractor shall scrutinise the Employer's Requirements (including design criteria and calculations, if any). If the Contractor discovers any error, fault or other defect in the Employer's Requirements, *Errors in the Employer's Requirements* shall apply (unless it is an error in the items of reference specified in the Employer's Requirements, in which case *Setting Out* clause shall apply).

The Contractor undertakes that the design of works, the Contractor's Documents, the execution of the Works and the completed Works will be in accordance with:

- a) The quality standards set by the Employer and meets industry norms & international standards applicable (i.e AWWA standards & specifications; Water Industry Mechanical and Electrical Specifications - WIMES) to potable/drinking water treatment plants and bulk water pump stations including conveyance systems
- b) The Laws of the Country- South Africa; and
- c) The documents forming the Contract, as altered or modified by Variations.

C3.2.3.2 **Basis of Design**

The Contractor shall perform the following:

- a) Scrutinise the tender drawings.
- b) Design the works and submit the designs to the Engineer. Designs shall be submitted for acceptance to the Engineer in the form of drawings or other appropriate documents.
- c) Submit certified drawings of requirements at equipment/building and piping interfaces.
- d) Approve the Engineer's drawings of new civil and new building details relating to equipment requirements. However no major civil and building works anticipated since major scope of mechanical and electrical works will have to fit within existing buildings which will not be modified.
- e) Install the equipment.
- f) Test and commission the equipment
- g) Trial Operation Period
- h) Maintain the plant during the twelve month Defects Notification Period from the date of the Certificate of Completion issued.

The periods during which the above actions will be performed may overlap, but tenderers shall be aware that the Engineer's progress in producing civil and building drawings affected by the Contractor's equipment will depend on the Contractor's timeous submission of adequate information

The Contractor shall:

- a) Develop the details of his design and execute the Works based upon and in congruence with:

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- i) Scope of Works.
 - ii) The drawings prepared by the Employer as tender drawings, and any subsequent revisions issued to the Contractor by the Engineer.
 - iii) Any other additional details issued to the Contractor by the Engineer.
- b) Ensure that his equipment fits into and can operate satisfactorily within the structures shown on the drawings.
- c) Obtain the Engineer's written acceptance of the information, specifications, performance details, calculations and drawings submitted. This acceptance shall be obtained before commencing with the purchase, manufacture, supply or construction of the relevant plant and equipment.
- d) The Engineer's acceptance shall not imply that the Engineer has checked the Contractor's designs, specifications or drawings for suitability, correctness or compliance with the Specification or that the Engineer has checked whether the plant and equipment will fit buildings or structures which are existing, are being built or will be built to suit the requirements of the Contractor as specified in drawings submitted by him for this purpose. The Contractor shall be entirely responsible for the adequacy of his design and for any errors, omissions or deficiency in any drawing, document or specification supplied by him, and for any loss, damage or expense arising therefrom, notwithstanding that such drawing, document or specification may have been approved by the Engineer.
- e) Bring to the attention of the Engineer any technical error or conflict in the Employer's requirements. The Engineer shall rule on such matters and the Contractor shall be bound to follow this ruling.
- f) Noting that drawings, dimensions and details of structures and equipment are supplied to the Contractor in good faith, and thus basing the design of equipment on actual dimensions, tolerance allowances and details measured/recorded on Site by himself and approved by the Engineer. The Contractor shall immediately report in writing to the Engineer, any inconsistencies, including any conflict between the drawings prepared by the Employer and the actual dimensions measured on Site.

C3.2.3.3 General Requirements

The Contractor's design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness as well as ease of maintenance and operation.

The Contractor's design shall allow for, as applicable:

- a) The full range of duties which can be reasonably anticipated, or otherwise are specified elsewhere in C3: Scope of Work.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- b) The maximum pressure or vacuum which can be produced under all conditions including blocked or closed inlet and outlet circuits.
- c) Conservative service and safety factors based on approved standards or as laid down in the printed specifications of reputable and approved manufacturers
- d) Twenty four hour per day operation availability on equipment (unless specified otherwise).
- e) A minimum life of 100 000 hours duty before major part replacement.
- f) Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as practical, mal-operation
- g) Machines with non-overloading characteristics shall be selected wherever possible; e.g.: motors shall be sized so that they cannot be overloaded by the driven machine.

C3.2.3.4 General Safety Requirements

- Safety of designs is an overriding consideration.
- Equipment which is potentially dangerous shall be designed in accordance with relevant South African or failing availability of such, international standards which deal with the hazard.
- Hazards shall be avoided or guarded to the approval of the Engineer. Nip points shall be guarded. Sharp corners shall be rounded off. Items such as operating handles, supports and protrusions shall be kept clear of access ways or shall be marked clearly.
- The Contractor shall cover all unsafe gaps and openings left in structures after installation of the equipment.
- Each motor driven device shall be provided with an emergency stop station in an appropriate position.
- Trip wires shall be provided along the accessible side/s of moving conveyor belts, chains, etc., irrespective of operating speed and in addition to any guards provided. These shall stop the driving motor when pulled.

C3.2.3.5 Compliance with Occupational Health and Safety Legislation

The Contractor is responsible for ensuring that the design of the equipment provided, and the installation of this equipment comply with the Occupational health and Safety Act, Act 85 of 1993, and the regulations promulgated thereunder.

Installations which do not comply shall be corrected by the Contractor at no cost to the Employer.

C3.2.3.6 Hazardous Locations

Equipment which is to be installed in areas with hazardous area location zoning for gasses or for dusts in terms of SANS 10108, shall comply with the requirements of that Standard

C3.2.3.7 Fail Safe Operations and Protections

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems shall be designed to be failsafe (i.e. shall have built in redundant elements) or shall be fail-to-safe (i.e. shall return to a safe condition where no further damage can be done in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse).

All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high risk situations, shall be incorporated. Such protections shall:

- a) Act quickly enough to prevent damage.
- b) Stop, or prevent from starting, all equipment at risk.
- c) Activate an alarm with a labelled indicator on the control panel, HMI or SCADA mimic whenever a protection operates.
- d) Operate reliably after long inactive periods exposed to corrosive and dirty conditions
- e) The Contractor shall highlight equipment limitations which can be exceeded during operation and cannot be guarded against.

C3.2.3.8 **Moving Parts**

The following general requirements shall apply to machines and to all equipment with moving parts such as headstocks, extension spindles, lifting equipment, swivelling davits, hinges, pivots and the like:

- a) Rotating or swivelling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.
- b) Swivelling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks.
- c) Abrasion resistant materials and slow speed operation shall be used for abrasive applications.
- d) Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. Sharp changes in section and badly contoured welding shall be avoided especially in components subject to fluctuating stress.
- e) The locking of nuts and pins in position shall be done to the approval of the Engineer.
- f) Wearing parts shall be designed for ease of removal and replacement.

C3.2.3.9 **Arrangement and Mounting**

- a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.
- b) Castings and fabrications shall have machined pads for seating and shall be mounted on either soleplates or base frames as appropriate.
- c) Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- d) The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc., shall be accommodated.

C3.2.3.10 Prevention of Corrosion

All items shall be designed to minimise corrosion in the environment in which they will be exposed.

Mastics, sealants, insertion rubber or suitable gasket material shall be used to seal unavoidable crevices between painted carbon steel surfaces or between unpainted stainless steel; e.g. bolted connections.

The design shall ensure that all surfaces to be coated shall be accessible for fettling, blast cleaning, painting and for maintenance of these surfaces. Stainless steel surfaces shall be accessible for pickling and passivation. The creation of inaccessible surfaces by use of back-to-back angles, partially open box sections or inaccessible stiffeners shall be avoided. Inaccessible surfaces which cannot be avoided shall be fully welded closed.

The design shall provide for and accommodate the fabrication and inspection requirements for **internal weld surfaces** in pipework.

C3.2.4 Design Review Workshop

The Contractor shall arrange, facilitate, host and participate in a series of design workshops at which the Engineer will be present. The purpose of these workshops is to proactively foster cooperation and collaboration between the respective teams of the Contractor and Engineer; so that:

- a) The Contractor's Design can be resolved and finalised efficiently, timeously, and in accordance with the requirements of C1.2: Contract Data and C3: Scope of Work.
- b) Instances where the Contractor's Design does not comply with C1.2: Contract Data and C3: Scope of Work, can be identified early and delays and other consequential problems averted.

The Contractor shall allow for a minimum of 15 X One day design workshops, which shall be held in Polokwane. The Contractor shall be responsible for all costs associated with the hire of the venue, audio-visual equipment required, and catering. The design team members for all components of the Works shall be present for and cooperatively participate in each design workshop. As a minimum, the Contractor's design team present shall include those staff proposed by the Contractor in his Schedule of Key Personnel Assigned to the Contract, as per the Contractor's Proposal. The Contractor shall allow for a team of 8 Representatives of the Engineer.

C3.2.5 HAZOP Study

The Contractor shall conduct a HAZOP study.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The Contractor shall arrange, facilitate, host and participate in a HAZOP study - for which a minimum of two days shall be allowed - at which representatives of the Employer and the Engineer will be present. The HAZOP study shall be held at a suitable conference venue within the Polokwane Municipal area or another mutually convenient location as approved by the Engineer. The Contractor shall be responsible for all costs associated with the hire of the venue, audio-visual equipment required, and catering. The Contractor shall allow for a team of 14 representatives combined from the Employer and the Engineer.

The Contractor shall employ a suitably experienced and independent consultant approved by the Engineer to lead the study in accordance with generally accepted industry practice. The consultant shall provide a report detailing the findings of the study. The study shall be

undertaken at a suitable location once the Contractor's Process and Instrumentation Diagrams have been approved by the Engineer for this purpose.

The Contractor's P&IDs shall be modified by the Contractor to reflect the decisions reached.

The Contractor's project manager, mechanical engineering designer and electrical engineering designer shall be present for the full duration of the study. Representatives of the Employer responsible for planning, design, maintenance, and operation will also be present.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.3 PROCUREMENT

NATIONAL TREASURY

NO. 47452

4 November 2022

PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT, 2000: PREFERENTIAL PROCUREMENT REGULATIONS

The Minister Finance has, in terms of section 5, read with section 2(1)(b)(i) and (ii) and 2(1)(c), of the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000), and with effect from 16 January 2023, made the regulations set out in the Schedule.

SCHEDULE

PREFERENTIAL PROCUREMENT REGULATIONS, 2022

Contents

1. Definitions
2. Application
3. Identification of preference point system
4. 80/20 preference point system for acquisition of goods or services with Rand value equal to or below R50 million
5. 90/10 preference point system for acquisition of goods or services with Rand value above R50 million
6. 80/20 preference points system for tenders to generate income or to dispose of or lease assets with Rand value equal to or below R50 million
7. 90/10 preference point system for tenders to generate income or to dispose of or lease assets with Rand value above R50 million
8. Criteria for breaking deadlock in scoring
9. Remedies
10. Repeal of regulations
11. Short title and commencement


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

Definitions

1. In these Regulations, unless the context indicates otherwise, any word or expression to which a meaning has been assigned in the Act must bear the meaning so assigned—

“highest acceptable tender” means a tender that complies with all specifications and conditions of tender and that has the highest price compared to other tenders;

“lowest acceptable tender” means a tender that complies with all specifications and conditions of tender and that has lowest price compared to other tenders;

“price” means an amount of money tendered for goods or services, and includes all applicable taxes less all unconditional discounts;

“Rand value” means the total estimated value of a contract in Rand, calculated at the time of the tender invitation;

“specific goals” means specific goals as contemplated in section 2(1)(d) of the Act which may include contracting with persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of race, gender and disability including the implementation of programmes of the Reconstruction and Development Programme as published in *Government Gazette* No. 16085 dated 23 November 1994;

“tender” means a written offer in the form determined by an organ of state in response to an invitation to provide goods or services through price quotations, competitive tendering process or any other method envisaged in legislation;

“tender for income-generating contracts” means a written offer in the form determined by an organ of state in response to an invitation for the origination of income-generating contracts through any method envisaged in legislation that will result in a legal agreement between the organ of state and a third party that produces revenue for the organ of state, and includes, but is not limited to, leasing and disposal of assets and concession contracts, excluding direct sales and disposal of assets through public auctions; and

“the Act” means the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000).

Application

2. These Regulations apply to organs of state as defined in section 11 of the Act.

Identification of preference point system

3.(1) An organ of state must, in the tender documents, stipulate—

- (a) the applicable preference point system as envisaged in regulations 4, 5, 6 or 7;
- (b) the specific goal in the invitation to submit the tender for which a point may be awarded, and the number of points that will be awarded to each goal, and proof of the claim for such goal.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- (2) If it is unclear whether the 80/20 or 90/10 preference point system applies, an organ of state must, in the tender documents, stipulate in the case of—
- (a) an invitation for tender for income-generating contracts, that either the 80/20 or 90/10 preference point system will apply and that the highest acceptable tender will be used to determine the applicable preference point system; or
- (b) any other invitation for tender, that either the 80/20 or 90/10 preference point system will apply and that the lowest acceptable tender will be used to determine the applicable preference point system.

80/20 preference point system for acquisition of goods or services with Rand value equal to or below R50 million

- 4.(1) The following formula must be used to calculate the points out of 80 for price in respect of an invitation for a tender with a Rand value equal to or below R50 million, inclusive of all applicable taxes:

$$P_s = 80 \left(1 - \frac{P_t - P_{\min}}{P_{\min}} \right)$$

Where—

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

$P_{\min}$ = Price of lowest acceptable tender.

- (2) A maximum of 20 points may be awarded to a tenderer for the specific goal specified for the tender.
- (3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.
- (4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

90/10 preference point system for acquisition of goods or services with Rand value above R50 million

- 5.(1) The following formula must be used to calculate the points out 90 for price in respect of an invitation for tender with a Rand value above R50 million, inclusive of all applicable taxes:



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

$$P_s = 90 \left(1 - \frac{P_t - P_{\min}}{P_{\min}} \right)$$

Where-

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

$P_{\min}$ = Price of lowest acceptable tender.

(2) A maximum of 20 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

80/20 preference points system for tenders for income-generating contracts with Rand value equal to or below R50 million

6.(1) The following formula must be used to calculate the points for price in respect of an invitation for tender for income-generating contracts, with a Rand value equal to or below R50 million, inclusive of all applicable taxes:

$$P_s = 80 \left(1 + \frac{P_t - P_{\max}}{P_{\max}} \right)$$

Where-

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

$P_{\max}$ = Price of highest acceptable tender.

(2) A maximum of 20 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

90/10 preference point system for tenders for income-generating



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

contracts with Rand value above R50 million

- 7.(1) The following formula must be used to calculate the points for price in respect of a tender for income-generating contracts, with a Rand value above R50 million, inclusive of all applicable taxes:

$$P_s = 90 \left(1 + \frac{P_t - P_{max}}{P_{max}} \right)$$

Where-

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

P_{max} = Price of highest acceptable tender.

A maximum of 10 points may be awarded to a tenderer for the specific goal specified for the tender.

- (2) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.
- (3) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

Criteria for breaking deadlock in scoring

- 8.(1) If two or more tenderers score an equal total number of points, the contract must be awarded to the tenderer that scored the highest points for specific goals.
- (2) If two or more tenderers score equal total points in all respects, the award must be decided by the drawing of lots.

Remedies

- 9.(1) If an organ of state is of the view that a tenderer submitted false information regarding a specific goal, it must—
- (a) inform the tenderer accordingly; and
- (b) give the tenderer an opportunity to make representations within 14 days as to why the tender may not be disqualified or, if the tender has already been awarded to the tenderer, the contract should not be terminated in whole or in part.
- (2) After considering the representations referred to in subregulation (1)(b), the organ of state may, if it concludes that such information is false—
- (a) disqualify the tenderer or terminate the contract in whole or in part; and
- (b) if applicable, claim damages from the tenderer.

Repeal of regulations

- 10.(1) Subject to this regulation, the Preferential Procurement Regulations, 2017 published in Government No. 40553 of 20 January 2017, are hereby

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- repealed with effect from the date referred to in regulation 11.
- (2) Any tender advertised before the date referred to in regulation 11 must be dealt with in terms of the Preferential Procurement Regulations, 2017.

Short title and commencement

11. These Regulations are called the Preferential Procurement Regulations, 2022 and take effect on 16 January 2023.

Specific Goals	Means of verification	90/10 Points
Disability (Minimum of 1 shareholder ownership in the company)	CSD Report	2,5
Black women (100% Black women ownership in the company)	CSD Report	2,5
Black ownership (100% black ownership in the company)	CSD Report	2,5
Black Youth (Minimum of 1 shareholder Black youth ownership in the company)	CSD Report	2,5
Total points		10

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.4 CONSTRUCTION

C3.4.1 Contractor's Representative

The Contractor shall appoint a Contractor's Representative and shall give him/her all authority necessary to act on the Contractor's behalf under the Contract, except to replace the Contractor's Representative.

The Contractor's Representative shall be qualified, experienced and competent in the main engineering discipline applicable to the Works and fluent in the language for communications which is English.

Unless the Contractor's Representative is named in the Contract, the Contractor shall, before the Commencement Date, submit to the Engineer for consent the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked, or if the appointed person fails to act as Contractor's Representative, the Contractor shall similarly submit the name and particulars of another suitable replacement for such appointment. If the Engineer does not respond within 28 days after receiving this submission, by giving a Notice to the Contractor objecting to the proposed person or replacement, the Engineer shall be deemed to have given his/her consent.

The Contractor shall not, without the Engineer's prior consent, revoke the appointment of the Contractor's Representative or appoint a replacement (unless the Contractor's Representative is unable to act as a result of death, illness, disability or resignation, in which case his/her appointment shall be deemed to have been revoked with immediate effect and the appointment of a replacement shall be treated as a temporary appointment until the Engineer gives his/her consent to this replacement, or another replacement is appointed, under this Sub-Clause).

The whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Contract. The Contractor's Representative shall act for and on behalf of the Contractor at all times during the performance of the Contract, including issuing and receiving all Notices and other communications and for receiving *Engineer's Instructions*.

The Contractor's Representative shall be based at the Site for the whole time that the Works are being executed at the Site. No construction activities/works shall be executed in the absence of Contractor's Representative. If the Contractor's Representative is to be temporarily absent from the Site during the execution of the Works, a suitable replacement shall be temporarily appointed, subject to the Engineer's prior consent.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The Contractor's Representative may delegate any powers, functions and authority except:

- a. the authority to issue and receive Notices and other communications ; and
- b. the authority to receive *Engineer's Instructions* issued

to any suitably competent and experienced person and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Engineer has received a Notice from the Contractor's Representative, naming the person, specifying the powers, functions and authority being delegated or revoked, and stating the timing of the delegation or revocation.

All these persons shall be fluent in English language for communications.

C3.4.2 Key Contractor's Personnel

PS 3.2.1 Recruitment Of Persons

The Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Employer's and Engineer's Personnel.

Neither the Employer nor the Engineer shall recruit, or attempt to recruit, staff and labour from amongst the Contractor's Personnel.

C3.4.2.2 Key Personnel for Construction Works

- a. **CV, Qualification and proof of Professional Registration of an Electrical Design Engineer** with minimum B-Tech/BSc Degree or higher in Electrical Engineering, Pr. Eng./Pr.Tech,Eng (ECSA), with experience in design electrical & electronic systems for water treatment works of at least 1000kW power (motor) capacity.
- b. **CV, Qualification and proof of Professional Registration of a Mechanical Design Engineer** with minimum B-Tech/BSc Degree or higher in Mechanical Engineering, Pr. Eng./Pr.Tech.Eng (ECSA), with experience in design mechanical systems for water treatment works and pump stations of at least 10ML/day flow capacity
- c. **Construction Project Manager** with a minimum BTech/BSc Degree of higher in Electrical or Mechanical or Civil Engineering, ECSA Pr. Eng. /Pr.Tech. Eng./Pr CM or Pr CPM with SACPCMP or GCC (Factories/Mines) and experience in construction site management (Construction Project Manager/Contracts Manager) role of water pump stations and/or water treatment plants construction and/or refurbishment projects of capacities of not less than 10ML/day flow capacity.
- d. **Site Manager** with a minimum National Diploma or higher in Electrical or Mechanical Engineering with experience in construction site management (Site Agent/Manager) role of water pump stations and/or water treatment plants construction and/or refurbishment projects of capacities of not less than 10ML/day flow capacity
- e. **Occupational Health and Safety (OHS) OHS Officer** with a minimum National Diploma (or higher in Safety Management or any relevant qualification, registration as construction health and safety manager

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

with SACPCMP and experience in construction as Health and Safety Officer/Manager construction project).

- f. **Construction Foreman** Detailed CV of key personnel Construction Foreman with a minimum N5 or higher in higher in Electrical, Millwright or Mechanical Engineering, TRADE TEST CERTIFICATE, and experience in construction and installation pumps, valves, electric motors, control and instrumentation equipment, electrical switchgear and control gear.
- g. **Coded Welder** with minimum of N4 or higher in Mechanical Engineering, Trade Test Certificate, Certified by SAIW as Coded Welder and minimum experience of 10years in welding of bulk water steel pipelines with proven continuous track-record of coded welding in the past 2 years.
- h. **Senior QA/QC Welding Inspector (IWI-S / SAIW Level 2)** with minimum of N4 or higher in Mechanical Engineering, Trade Test Certificate, Certified by SAIW as Welding Inspector Level 2 and minimum experience of 15years in welding of bulk water steel pipelines with proven continuous track-record of welding inspection in the past 3 years.

C3.4.3 Commencement of Works

The Engineer shall give a Notice to the Contractor stating the Commencement Date, not less than 14 days before the Commencement Date. Unless otherwise stated in the Particular Conditions, the Commencement Date shall be within 42 days after the Contractor receives the Letter of Acceptance. The Contractor shall commence the execution of the Works on, or as soon as is reasonably practicable after, the Commencement Date and shall then proceed with the Works with due expedition and without delay.

C3.4.4 Contractor's Superintendence

From the Commencement Date until the issue of the Performance Certificate, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect, test and monitor the execution of the Works. Superintendence shall be given by a sufficient number of persons:

- a) who are fluent in or have adequate knowledge of the language for communications which is English
- b) who have adequate knowledge of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Works

C3.4.5 Contractor's Personnel

The Contractor's Personnel (including Key Personnel, if any) shall be appropriately qualified, Professionally Registered with ECSA, skilled, experienced and competent in their respective trades or occupations.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Engineer may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representative and Key Personnel (if any), who:

- a) Does not minimum requirements such as Professional Registration and qualifications
- b) Persists in any misconduct or lack of care.
- c) Carries out duties incompetently or negligently.
- d) Fails to comply with any provision of the Contract.
- e) persists in any conduct which is prejudicial to safety, health, or the protection of the environment.
- f) Is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice; or
- g) Has been recruited from the Employer's and Engineer's Personnel without mutual agreement with the Employer and Engineer.

If appropriate, the Contractor shall then promptly appoint (or cause to be appointed) a suitable replacement. In the case of the replacement of the Contractor's Representative, Sub-Clause PS 3.1 [*Contractor's Representative*] shall apply. In the case of the replacement of Key Personnel (if any), Sub-Clause PS 3.2 [*Key Personnel*] shall apply.

C3.4.6 Time for Completion of Works

The Contractor shall complete the whole of the Works, and each Section (if any), within the Time for Completion for the Works or Section (as the case may be), including completion of all work which is stated in the Contract as being required for the Works or Section to be considered to be completed for the purposes of taking over.

C3.4.7 Contractor's Camp Establishment

The contractor shall make his own arrangements regarding the establishment of a camp site and housing for his construction personnel and all regulations stipulated by the local authority shall be adhered to. The Contractor is responsible for providing a suitable site for his camp and to provide accommodation for his personnel and labourers. Apart from essential security services, the Contractor shall not accommodate his staff on Site. The Contractor's personnel will only be allowed on Site for the duration of a working day.

The Contractor shall be responsible for identifying suitable positions (subject to the designated sites shown on the drawings and to the approval of the Engineer) to locate all facilities, including, as necessary, construction camps, offices, stores, workshops and testing facilities required for the due and proper performance of the Contract. The proposed site camp positions shall be submitted to the

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Engineer for approval. Accordingly, a general layout drawing to a scale of not less than 1:200 shall be submitted to the Engineer for approval prior to commencing any work on the camp or offices.

The Contractor shall have sole use of such area, free of charge, until Completion of the Works is achieved. The Contractor shall use this area only for the purposes of erecting his site offices, workshops, stores and other facilities required for the execution of the Contract. The Contractor shall not use the area nor allow it to be used for any purposes not directly associated with the execution of the Contract.

The Contractor shall supply and maintain adequate and suitable sheds for the storage of materials that might deteriorate if exposed to the weather.

The Contractor shall, as specified in the Amendments to SANS 1200 AB, provide, maintain and keep clean all facilities to be provided for the Engineer and all other facilities for all persons engaged in the works.

On completion of the Works, or when the facilities provided by the Contractor are no longer required, the Contractor shall remove them and clear away all surface indications of their presence.

C3.4.8 Security

The Contractor may be exposed to criminal actions such as theft and vandalism, and shall make the necessary security arrangements for the duration of the Contract. Any such costs arising from this shall be covered under the rates tendered for the Preliminary and General items in the Bill of Quantities.

The Contractor shall enclose the whole camp site areas with a security fence to ensure that unauthorised persons cannot enter. Provision is made in these specifications for the erection of a security fence around the site offices. The contractor shall be responsible for the security of his personnel and constructional plant on and around the site of the works and for the security of his camp, and the employer will consider no claims in this regard.

The Contractor shall remove the fencing and rehabilitate the camp site areas on completion of the Contract.

C3.4.9 Site Services

It is anticipated that the contractor's choice of a camp site will be influenced by the availability of telephone and electrical connections as well as the supply of potable water.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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 to be included in the rates and amounts tendered for the various items of work for which these services are required.

There is power available on site at the electrical substation and for light duty at different pump station buildings. The contractor must supply all temporary major connections at the pump stations & works and connect directly to this substation where he will install an electrical meter. The use of electricity will be monitored and charged for at the Eskom current charge out rates by the owner for payment by the contractor. The client cannot guarantee supply of power and is noted that outage is common in the area. The contractor must make his own arrangements for emergency power supply to his camp and especially at critical machinery and plant of his operation. No extension of time for outage will be entertained. It is to be noted that a certified electrician must correctly install all site electrical extensions.

The employer will make metered potable water available at a standard charge of R5.00 per m³ for the normal execution of the works and the needs of the labour force on site. The Contractor shall make his own arrangements with the employer for a suitable connection point for a water supply for contractors' camp and construction purposes. Such installation inclusive of any water pipes and dispense taps will be for the contractor account. The contractor shall install at his expense a water meter to monitor the consumption of water and also will be liable for any punitive payments required in regard to excessive use of water.

The following are noted:

- The Pump Stations and purification works have water available for use by the contractor, but the contractor's attention is drawn to the fact that water will not be available at certain periods during the refurbishment stage which he will be carrying out as well during the often occurring on site outage. The cost of the line to the main contractor camp will have to be borne by the general P&G rates offered. The connection point would be in the vicinity of the main water tower. The client cannot guarantee either the water supply or the water quality. Especially the water for drinking purposes.
- The Contractor shall comply with any measures regarding restrictions on the use of water laid down by the Employer from which water is directly or indirectly obtained

C3.4.10 Notices, Signs Barricades and Advertisements

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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

C3.4.11 Rail Facilities

The Contractor shall be responsible for determining the nearest reliable goods handling station if such facilities are required.

C3.4.12 Lifting Facilities

The Contractor shall make his own arrangement for lifting facilities

C3.4.13 Sanitary Facilities & Conditions

The Contractor shall ensure that sanitary conditions prevail throughout the site and that all his workmen are aware of, and comply with this requirement. Unhygienic habits, littering and any behaviour that may cause contamination of any part of the Works or the surrounding areas are prohibited.

The Contractor shall provide adequate toilet and ablution facilities for all his personnel on Site in accordance with the requirements of the Environmental Specifications and Environmental Management Plan. Wastewater shall not be discharged to the local environment.

C3.4.14 Maintaining and cleaning of the site

The Contractor shall maintain the Site in a clean, tidy and orderly condition to the approval of the Engineer. The Contractor shall store materials and equipment for which he is responsible in an orderly manner, and shall keep the Site free from debris and obstructions.

The Contractor shall repair/rebuild any damage resulting from the Contractor's activities on Site. This includes repairs/rebuilds any damage to the Site, civil and building constructions and any of the Employer's and the Engineer's property.

C3.4.15 Engineer's Office and Facilities for the Engineer

Refer to the Amendments to SANS 1200 AB

In addition, before commencing activities on Site and until the Completion Certificate is issued, the Contractor shall provide, maintain and keep clean an office for the sole use by the Engineer's staff.

C3.4.16 Adjacent Properties, Existing Structures and Services

The Contractor shall so carry out his operations as not to cause damage to any existing infrastructure and shall not trespass or encroach on to any property adjacent.

The Contractor shall protect any existing services on and in the vicinity of the Site against damage which may arise as a result of his operations. Refer to PSA 5.4 of the SANS 1200 Amendments



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.4.17 Normal Working Hours

If the Contractor is given permission, in terms of C1.2: Contract Data, to work outside the agreed working hours, he shall arrange with the Engineer, in good time, for watching and supervision of the Works; he shall be responsible for paying the additional costs of watching and supervising incurred by the Engineer and he shall provide adequate lighting for the construction area and access as necessary.

Normal working hours are 07h00 to 16h30. In the event of an emergency call-outs, a 24hour standby is required, seven days a week.

The non-working days are Saturday, Sunday and all statutory holidays declare by National or Provincial Government

C3.4.18 Lighting

Should the Contractor wish to work when the natural light is inadequate for the type of work to be undertaken he shall, at his own expense, provide and maintain in good condition, adequate high-powered flood lighting for all portions of the work over which he is operating.

C3.4.19 Continuance of Operation of Existing Services

All existing services shall be maintained in operation, unless prior arrangements have been made with the relevant authority and written permission for an interruption of the service has been granted and adequate notice has been given to the affected parties.

Electricity and water supply interruptions in existing residential areas shall be kept to a minimum. The Engineer's approval shall be obtained prior to such interruptions and residents shall be notified in writing at least 24 hours in advance. Supplies shall be normalised by 16:00 on the same day.

The Contractor shall take care to protect existing services against damage.

C3.4.20 Construction Area

The Contractor shall ensure that he does not cause any damage whatsoever outside the specified construction area, and will be held liable for damage outside the construction area.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.4.21 Dust Control

The Contractor shall take sufficient and effective measures to reduce and limit excessive dust or wind-blown debris on the Site and as a result of the construction activities, affect adjacent property owners. Such measures shall include, but not be limited to, watering down as frequently as necessary, covering up the sources and enclosing.

C3.4.22 Abnormal Weather Conditions

In terms of C1.2: Contract Data, extension of time will be considered for abnormal climatic conditions in accordance with the following:

No extension of time for completion will be granted on account 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_w = Actual number of days during the relevant calendar month on which Y mm or more of rainfall has been recorded.

N_n = Average number of days in the relevant calendar month on which Y mm or more of rainfall has been recorded, as derived from the rainfall records provided in the Project Specification.

R_w = Actual rainfall in mm for the calendar month under consideration.

R_n = Average rainfall in mm for the relevant calendar month, as derived from the rainfall records provided in the Project Specifications.

If V is negative and its absolute value exceeds N_n, then V shall be taken as equal to minus N_n.

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

X = 20 mm/d Y = 10 mm

Extensions of time for part of a month shall be calculated using pro rata values of N_n and R_n.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 $(N_w - N_n)$ shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds Y mm.

The factor $(R_w - R_n)/X$ 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_n and R_n 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 No 0677802BX, for the period 1992 to 2016 are reproduced in the table below and the monthly averages (N_n and R_n) for this period will be taken as the normal rainfall for the purposes of this Contract.

MONTH	(R_n)	(N_n)
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


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

December	96.0	12.0
YEAR	494.9	73.3

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.

C3.4.23 Requirements Prior To Installation Of Equipment

The following conditions shall be met before the Contractor commences with installation of equipment required in terms of the Mechanical and Electrical Works – Pump Station:

Concrete plinths has been sufficiently cured up to specified strength to allow installation work to start. Proof shall be provided to indicate concrete strength.

C3.4.24 Material and Samples

Materials or work which do not conform to the approved samples submitted in terms of Clause 7.4.1 of the Conditions of Contract, will be rejected. The Engineer reserves the right to submit samples to tests to ensure that the material represented by the sample meets the specification requirements.

The costs of any such tests conducted by or on behalf of the Engineer, the results of which indicate that the samples provided by the Contractor do not conform to the requirements of the Contract, shall, in accordance with the provisions of Clause 7.4.4 of the Conditions of Contract, be for the Contractor’s account

C3.4.25 Testing and Quality Control

C3.4.25.1 Contractor to engage services of an independent laboratory

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

The Contractor shall be responsible for arranging with the independent testing laboratory for the timeous carrying out of all such testing specified in the Contract, at not less than the frequencies and

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

in the manner specified. The Contractor shall promptly provide the Engineer with copies of the results of all such testing carried out by the independent laboratory.

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

C3.4.25.2 Additional testing required by the Engineer

In addition to the provisions of sub-clause C3.4.25.1, the Contractor is to engage services of an independent laboratory, the Engineer shall be entitled at times during the Contract to require that the Contractor arrange with the independent laboratory to carry out any such tests, additional to those described in sub-clause C3.4.25.1 at such times and at such locations in the Works as the Engineer shall prescribe. The Contractor shall promptly and without delay arrange with the independent laboratory for carrying out all such additional testing as required by the Engineer, and copies of the test results shall be promptly submitted to the Engineer.

C3.4.25.3 Costs of testing

The costs of all testing carried out by the independent laboratory in accordance with above shall be borne by the Contractor and shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities and which require testing in terms of the Specifications. No separate payments will be made by the Employer to the Contractor in respect of any testing carried out in terms of sub-clause C3.4.25.1.

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

C3.4.25.3 Cost of Additional tests required by the Engineer

Additional testing required by the Engineer, shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Bill of Quantities; provided always that the costs of any such additional tests ordered by the Engineer, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved are/is not in accordance with the specifications, shall not be reimbursable to the Contractor.

C3.4.26 Workmanship and Quality Control

C3.4.26.1 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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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

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

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

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

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

The Contractor shall prepare a quality management plan to be followed during the course of the Contract.

The quality management plan shall:

- a) Clearly indicate the methods, programmes, procedures and other methods that the Contractor intends using as process control to ensure compliance of materials and workmanship with the requirements of the Contract.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- b) Include the proof of status of calibration of all measuring devices that are to be used during the course of the Contract.

C3.4.26.2 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.

- a) The Quality Control and Assurance System to be submitted shall include but not necessarily be limited to the following:
- b) 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.
- c) Programme requirements for plant production with detailed description of Quality Assurance organization of the Contractor, Quality Assurance Functions and Procedures and Performance Monitoring.
- d) Quality Assurance Programme Tests with detailed description of the test procedures to be conducted.
- e) In addition to the requirements of these ISO Standards or their equivalents the Contractor shall:
- f) Establish procedures for adequate planning and resourcing of all quality related activities including the preparation of quality plans.
- g) 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.
- h) Arrange for the protection of quality of the product to include delivery to the specified destination.
- i) 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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

C3.4.26.3 **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

C3.4.26.4 **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.

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Failure to confirm 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.

C3.4.26.5. 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.

PS 3.26.6 Inspections

PS 3.26.6.1 Inspections of entire Works

The Employer's Personnel shall, during all the normal working hours stated in the Contract Data and at all other reasonable times:

- a) have full access to all parts of the Site and to all places from which natural Materials are being obtained;
- b) during production, manufacture and construction (at the Site and elsewhere), be entitled to:
 - i) examine, inspect, measure and test (to the extent stated in the Employer's Requirements) the Materials, Plant and workmanship,
 - ii) check the progress of manufacture of Plant and production and manufacture of Materials, and
 - iii) make records (including photographs and/or video recordings); and
- c) carry out other duties and inspections, as specified in these Conditions and the Employer's Requirements.

The Contractor shall give the Employer's Personnel full opportunity to carry out these activities, including providing safe access, facilities, permissions and safety equipment.

The Contractor shall give a Notice to the Engineer whenever any Materials, Plant or work is ready for inspection, and before it is to be covered up, put out of sight, or packaged for storage or transport. The Employer's Personnel shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or the Engineer shall promptly give a Notice to the Contractor that the Employer's Personnel do not require to do so. If the Engineer gives no such Notice and/or the Employer's Personnel do not attend at the time stated in the Contractor's Notice (or such time as may be agreed with the Contractor), the Contractor may proceed with covering up, putting out of sight or packaging for storage or transport.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

If the Contractor fails to give a Notice in accordance with this Sub-Clause, the Contractor shall, if and when required by the Engineer, uncover the work and thereafter reinstate and make good, all at the Contractor's risk and cost.

C3.4.26.6.2 Inspections During Manufacturing

The Engineer shall be entitled at all reasonable times during manufacture to inspect, examine and test on the Contractor's premises the materials and workmanship and check the progress of all plant and equipment to be supplied in terms of the Design Works. If part of the said plant or equipment is being manufactured on other premises the Contractor shall obtain for the Engineer permission to inspect, examine and test as if the said plant or equipment were being manufactured on the Contractor's premises. Such inspection, examination or testing, if made, shall not release the Contractor from any obligations under the Contract.

Specified inspections are to be witnessed by the Engineer and all inspections are to be done by the Engineer. The Contractor shall make all arrangements and pay all necessary costs for the Engineer's transport, accommodation, etc

C3.4.26.7 Corrosion Protection

The Contractor shall provide adequate internal supervision to ensure that the requirements of the corrosion protection specifications are adhered to.

In addition, during any of the corrosion protection activities specified, there shall be a senior supervisor available to accept instructions from the Engineer (or an Engineer's representative; e.g. an appointed inspection authority). Corrosion protection shall comply with specifications Mech 0003: General Corrosion Protection for Pipelines, Water Treatment Works and Pump Stations.

C3.4.26.8 Testing by the Contractor, Completion and Correction of defects

This Sub-Clause shall apply to all tests specified in the Contract, other than the Tests after Completion (if any).

The Contractor shall provide all apparatus, assistance, documents and other information, temporary supplies of electricity and water, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified, experienced and competent staff, as are necessary to carry out the specified tests efficiently and properly. All apparatus, equipment and instruments shall be calibrated in accordance with the standards specified in the Employer's Requirements or defined by applicable Laws and, if requested by the Engineer, the Contractor shall submit calibration certificates before carrying out testing.

The Contractor shall give a Notice to the Engineer, stating the time and place for the specified testing of any Plant, Materials and other parts of the Works.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

This Notice shall be given in reasonable time, having regard to the location of the testing, for the Employer's Personnel to attend.

The Engineer may, vary the location or timing or details of specified tests, or instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested Plant, Materials or workmanship is not in accordance with the Contract, the Cost and any delay incurred in carrying out this Variation shall be borne by the Contractor.

The Engineer shall give a Notice to the Contractor of not less than 72 hours of his/her intention to attend the tests. If the Engineer does not attend at the time and place stated in the Contractor's Notice under this Sub-Clause, the Contractor may proceed with the tests, unless otherwise instructed by the Engineer, which tests shall then be deemed to have been made in the Engineer's presence.

If the Contractor suffers delay and/or incurs Cost from complying with any such instruction or as a result of a delay for which the Employer is responsible, the Contractor shall be entitled subject to (*Claims For Payment and/or EOT*) to EOT and/or payment of Cost Plus Profit.

If the Contractor causes any delay to specified tests (including varied or additional tests) and such delay causes the Employer to incur costs, the Employer shall be entitled subject to (*Claims For Payment and/or EOT*) payment of these costs by the Contractor. The Contractor shall promptly forward to the Engineer duly certified reports of the tests. When the specified tests have been passed, the Engineer shall endorse the Contractor's test certificate, or issue a test certificate to the Contractor, to that effect. If the Engineer has not attended the tests, he/she shall be deemed to have accepted the readings as accurate.

Defects and Rejection shall apply in the event that any Plant, Materials and other parts of the Works fails to pass a specified test.

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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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/startup 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:

- i) The addition of procedural changes and other reasonable tests to reasonably assure System performance and conformance.
- ii) Investigation into any apparent troubles or anomalies with respect to the System.
- iii) 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

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C3.4.26.9 Defects and Rejection

This clause shall be read together with GCC 2015 Clause 7.8 (Defects).

If, as a result of an examination, inspection, measurement or testing, any Plant, Materials, design or workmanship is found to be defective or otherwise not in accordance with the Contract, the Engineer



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

shall give a Notice to the Contractor describing the item of Plant, Materials, design or workmanship that has been found to be defective. The Contractor shall then promptly prepare and submit a proposal for necessary remedial work.

The Engineer may Review this proposal and may give a Notice to the Contractor stating the extent to which the proposed work, if carried out, would not result in the Plant, Materials, design or workmanship complying with the Contract. After receiving such a Notice the Contractor shall promptly submit a revised proposal to the Engineer. If the Engineer gives no such Notice within 14 days after receiving the Contractor's proposal (or revised proposal), the Engineer shall be deemed to have given a Notice of No-objection.

If the Contractor fails to promptly submit a proposal (or revised proposal) for remedial work, or fails to carry out the proposed remedial work to which the Engineer has given (or is deemed to have given) a Notice of No-objection, the Engineer may:

(a) instruct the Contractor under sub-paragraph (a) and/or (b) of Sub-Clause PS 3.26.10 [*Remedial Work*]; or

(b) reject the design, Plant, Materials or workmanship by giving a Notice to the Contractor, with reasons, in which case sub-paragraph (a) of Sub-Clause C3.4.28.4 [*Failure to Remedy Defects*] shall apply.

After remedying defects in any Plant, Materials, design or workmanship, if the Engineer requires any such items to be retested, the tests shall be repeated in accordance with Sub-Clause C3.4.26.8 [*Testing by the Contractor*] at the Contractor's risk and cost. If the rejection and retesting cause the Employer to incur additional costs, the Employer shall be entitled subject to [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor.

C3.4.26.10 Remedial Work

In addition to any previous examination, inspection, measurement or testing, or test certificate or Notice of No-objection by the Engineer, at any time before the issue of the Taking-Over Certificate for the Works the Engineer may instruct the Contractor to:

- a) repair or remedy (if necessary, off the Site), or remove from the Site and replace any Plant or Materials which are not in accordance with the Contract.
- b) repair or remedy, or remove and re-execute, any other work which is not in accordance with the Contract; and
- c) carry out any remedial work which is urgently required for the safety of the Works, whether because of an accident, unforeseeable event or otherwise.

The Contractor shall comply with the instruction as soon as practicable and not later than the time (if any) specified in the instruction, or immediately if urgency is specified under sub-paragraph (c) above.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall bear the cost of all remedial work required under this Sub-Clause, except to the extent that any work under sub-paragraph (c) above is attributable to:

- i) any act by the Employer or the Employer's Personnel. If the Contractor suffers delay and/or incurs Cost in carrying out such work, the Contractor shall be entitled subject to [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit; or

If the Contractor fails to comply with the Engineer's instruction, the Employer may (at the Employer's sole discretion) employ and pay other persons to carry out the work. Except to the extent that the Contractor would have been entitled to payment for work under this Sub-Clause, the Employer shall be entitled subject [*Claims For Payment and/or EOT*] to payment by the Contractor of all costs arising from this failure. This entitlement shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

C3.4.26.11 Contractor's Obligations for Test On Completion

The Contractor shall carry out the Tests on Completion in accordance with this Clause and Sub Clause C3.4.26.8 [*Testing by the Contractor*], after submitting the documents under Sub-Clause C3.6.1.6 [*As-Built Records*] and Sub-Clause C3.6.1.7 [*Operation and Maintenance Manuals*].

The Contractor shall submit to the Engineer, not less than 42 days before the date the Contractor intends to commence the Tests on Completion, a detailed test programme showing the intended timing and resources required for these tests.

The Engineer may Review the proposed test programme and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract. Within 14 days after receiving this Notice, the Contractor shall revise the test programme to rectify such non-compliance. If the Engineer gives no such Notice within 14 days after receiving the test programme (or revised test programme), the Engineer shall be deemed to have given a Notice of No-objection. The Contractor shall not commence the Tests on Completion until a Notice of No-objection is given (or is deemed to have been given) by the Engineer.

In addition to any date(s) shown in the test programme, the Contractor shall give a Notice to the Engineer, of not less than 21 days, of the date after which the Contractor will be ready to carry out each of the Tests on Completion. The Contractor shall commence the Tests on Completion within 14 days after this date, or on such day or days as the Engineer shall instruct, and shall proceed in accordance with the Contractor's test programme to which the Engineer has given (or is deemed to have given) a Notice of No-objection.


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

Unless otherwise stated in the Employer's Requirements, the Tests on Completion shall be carried out in stages in the following sequence:

- (a) pre-commissioning tests (on or off the Site, as appropriate), which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of the Works or Section can safely undertake the next stage under sub-paragraph (b) below.
- (b) commissioning tests, which shall include the operational tests specified in the Employer's Requirements to demonstrate that the Works or Section can be operated safely and as specified in the Employer's Requirements, under all available operating conditions; and
- (c) trial operation (to the extent possible under available operating conditions), which shall demonstrate that the Works or Section perform reliably and in accordance with the Contract.

The tests of each stage described in sub-paragraphs (b) and (c) above shall not be commenced until the Works or Section have passed the previous stage.

During trial operation, when the Works or Section (as the case may be) are operating under stable conditions, the Contractor shall give a Notice to the Engineer that they are ready for any other Tests on Completion, including performance tests. Performance tests shall be carried out to demonstrate whether the Works or Section comply with the performance criteria specified in the Employer's Requirements and with the Schedule of Performance Guarantees.

Trial operation, including performance testing, shall not constitute a taking over under Clause C3.4.27 [*Employer's Taking Over*].

Any product produced by, and any revenue or other benefit resulting from, trial operation under this Sub-Clause shall be the property of the Employer. As soon as the Works or Section have, in the Contractor's opinion, passed each stage of the Tests on Completion described in sub-paragraphs (a) to (c) above, the Contractor shall submit a certified report of the results of these tests to the Engineer. The Engineer shall Review each such report and may give a Notice to the Contractor stating the extent to which the results of the tests do not comply with the Contract. If the Engineer does not give such a Notice within 14 days after receiving the results of the tests, the Engineer shall be deemed to have given a Notice of No-objection.

In considering the results of the Tests on Completion, the Engineer shall make allowances for the effect of any use of (any part of) the Works by the Employer on the performance or other characteristics of the Works.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.4.26.12 **Delayed Tests**

If the Contractor has given a Notice under Sub-Clause C3.4.26.11 [*Contractor's Obligations*] that the Works or Section (as the case may be) are ready for Tests on Completion, and these tests are unduly delayed by the Employer's Personnel or by a cause for which the Employer is responsible, Sub-Clause C3.4.27.3 [*Interference with Tests on Completion*] shall apply.

If the Tests on Completion are unduly delayed by the Contractor, the Engineer may by giving a Notice to the Contractor require the Contractor to carry out the tests within 21 days after receiving the Notice. The Contractor shall carry out the tests on such day or days within this period of 21 days as the Contractor may fix, for which the Contractor shall give a prior Notice to the Engineer of not less than 7 days.

If the Contractor fails to carry out the Tests on Completion within this period of 21 days:

- (a) after a second Notice is given by the Engineer to the Contractor, the Employer's Personnel may proceed with the tests.
- (b) the Contractor may attend and witness these tests.
- (c) within 28 days of these tests being completed, the Engineer shall send a copy of the test results to the Contractor: and
- (d) if the Employer incurs additional costs as a result of such testing, the Employer shall be entitled subject to payment by the Contractor of the costs reasonably incurred under *Claims for Payment and/or EOT*

Whether or not the Contractor attends, these Tests on Completion shall be deemed to have been carried out in the presence of the Contractor and the results of these tests shall be accepted as accurate.

C3.4.26.13 **Retesting**

If the Works, or a Section, fail to pass the Tests on Completion, Sub-Clause C3.4.26.9 [*Defects and Rejection*] shall apply. The Engineer or the Contractor may require these failed tests, and the Tests on Completion on any related work, to be repeated under the same terms and conditions. Such repeated tests shall be treated as Tests on Completion for the purposes of this Clause.

C3.4.26.14 **Failure to Pass Tests on Completion**

If the Works, or a Section, fail to pass the Tests on Completion repeated under Sub-Clause PS 3.26.13 [*Retesting*], the Engineer shall be entitled to:

- (a) order further repetition of Tests on Completion under Sub-Clause C3.4.26.13 [*Retesting*];



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- (b) reject the Works if the effect of the failure is to deprive the Employer of substantially the whole benefit of the Works, in which event the Employer shall have the same remedies as are provided in sub-paragraph (d) of Sub-Clause C3.4.28.4 [*Failure to Remedy Defects*];
- (c) reject the Section if the effect of the failure is that the Section cannot be used for its intended purpose(s) under the Contract, in which event the Employer shall have the same remedy as is provided in sub-paragraph (c) of Sub-Clause PS 3.28.4 [*Failure to Remedy Defects*]; or
- (d) issue a Taking-Over Certificate, if the Employer so requests.

In the event of sub-paragraph (d) above, the Contractor shall then proceed in accordance with all other obligations under the Contract, and the Employer shall be entitled subject to Sub-Clause 20.2] to payment by the Contractor or a reduction in the Contract Price as described under sub-paragraphs (b)(i) or (b)(ii) of Sub-Clause C3.4.28.4 [*Failure to Remedy Defects*], respectively. This entitlement shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

C3.4.26.15 Quality Management and Compliance Verification Systems

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

C3.4.26.15.1 Quality Management System

The Contractor shall prepare and implement a QM System to demonstrate compliance with the requirements of the Contract. The QM System shall be specifically prepared for the Works and submitted to the Engineer within 28 days of the Commencement Date. Thereafter, whenever the QM System is updated or revised, a copy shall promptly be submitted to the Engineer.

The QM System shall be in accordance with the details stated in the Employer's Requirements (if any) and shall include the Contractor's procedures:

- (a) to ensure that all Notices and other communications under *Notices and Other Communications*, Contractor's Documents, as-built records, O&M Manuals, and contemporary records can be traced, with full certainty, to the Works, Goods, work, workmanship or test to which they relate.
- (b) to ensure proper coordination and management of interfaces between the stages of execution of the Works, and between Subcontractors; and
- (c) for the submission of Contractor's Documents to the Engineer for Review.

The Engineer may Review the QM System and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract. Within 14 days after receiving this Notice, the Contractor shall revise the QM System to rectify such non-compliance. If the Engineer does not give such a


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

Notice within 21 days of the date of submission of the QM System, the Engineer shall be deemed to have given a Notice of No-objection.

The Engineer may, at any time, give a Notice to the Contractor stating the extent to which the Contractor is failing to correctly implement the QM System to the Contractor's activities under the Contract. After receiving this Notice, the Contractor shall immediately remedy such failure.

The Contractor shall carry out internal audits of the QM System regularly, and at least once every 6 months. The Contractor shall submit to the Engineer a report listing the results of each internal audit within 7 days of completion. Each report shall include, where appropriate, the proposed measures to improve and/or rectify the QM System and/or its implementation.

If the Contractor is required by the Contractor's quality assurance certification to be subject to external audit, the Contractor shall immediately give a Notice to the Engineer describing any failing(s) identified in any external audit. If the Contractor is a JV, this obligation shall apply to each member of the JV.

C3.4.26.15.2 Quality Compliance Verification System

The Contractor shall prepare and implement a Compliance Verification System to demonstrate that the design, Materials, Employer-Supplied Materials (if any), Plant, work and workmanship comply in all respects with the Contract.

The Compliance Verification System shall be in accordance with the details stated in the Employer's Requirements (if any) and shall include a method for reporting the results of all inspections and tests carried out by the Contractor. In the event that any inspection or test identifies a non-compliance with the Contract, Sub-Clause C3.4.26.9 [*Defects and Rejection*] shall apply.

The Contractor shall prepare and submit to the Engineer a complete set of compliance verification documentation for the Works or Section (as the case may be), fully compiled and collated in the manner described in the Employer's Requirements or, if not so described, in a manner acceptable to the Engineer.

C3.4.26.15.3 Quality General provision

Compliance with the QM System and/or Compliance Verification System shall not relieve the Contractor from any duty, obligation or responsibility under or in connection with the Contract.

C3.4. 27 Employer's Taking Over

C3.4. 27.1 Taking Over the Works and Sections

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Except as stated in Sub-Clause C3.4.26.14 [*Failure to Pass Tests on Completion*], Sub-Clause C3.4.27.2 [*Taking Over Parts*] and Sub-Clause C3.4.27.3 [*Interference with Tests on Completion*], the Works shall be taken over by the Employer when:

- (a) the Works have been completed in accordance with the Contract, including the passing of the Tests on Completion and except as allowed in sub-paragraph (i) below;
- (b) the Engineer has given (or is deemed to have given) a Notice of No-objection to the as-built records submitted under sub-paragraph (a) of Sub-Clause C3.6.1.6 [*As-Built Records*];
- (c) the Engineer has given (or is deemed to have given) a Notice of No-objection to the provisional O&M Manuals for the Works submitted under Sub-Clause C3.6.1.7 [*Operation and Maintenance Manuals*];
- (d) the Contractor has carried out the training (if any) as described under Sub-Clause C3.5.11.7, C3.6.1.5 & C3.7.7 [*Training*]; and
- (e) a Taking-Over Certificate for the Works has been issued, or is deemed to have been issued in accordance with this Sub-Clause.

The Contractor may apply for a Taking-Over Certificate by giving a Notice to the Engineer not more than 14 days before the Works will, in the Contractor's opinion, be complete and ready for taking over. If the Works are divided into Sections, the Contractor may similarly apply for a Taking-Over Certificate for each Section. If any Part of the Works is taken over under Sub-Clause C3.4.27.2 [*Taking Over Parts*], the remaining Works or Section shall not be taken over until the conditions described in sub-paragraphs (a) to (e) above have been fulfilled.

The Engineer shall, within 28 days after receiving the Contractor's Notice, either:

- (i) issue the Taking-Over Certificate to the Contractor, stating the date on which the Works or Section were completed in accordance with the Contract, except for any minor outstanding work and defects (as listed in the Taking-Over Certificate) which will not substantially affect the safe use of the Works or Section for their intended purpose (either until or whilst this work is completed, and these defects are remedied); or
- (ii) reject the application by giving a Notice to the Contractor, with reasons. This Notice shall specify the work required to be done, the defects required to be remedied and/or the documents required to be submitted by the Contractor to enable the Taking-Over Certificate to be issued. The Contractor shall then complete this work, remedy such defects and/or submit such documents before giving a further Notice under this Sub-Clause.

If the Engineer does not issue the Taking-Over Certificate or reject the Contractor's application within this period of 28 days, and if the conditions described in sub-paragraphs (a) to (d) above have been



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

fulfilled, the Works or Section shall be deemed to have been completed in accordance with the Contract on the fourteenth day after the Engineer receives the Contractor's Notice of application and the Taking-Over Certificate shall be deemed to have been issued.

C3.4. 27.2 Taking Over Parts

The Engineer may, at the sole discretion of the Employer, issue a Taking-Over Certificate for any part of the Permanent Works.

The Employer shall not use any part of the Works (other than as a temporary measure, which is either specified in the Employer's Requirements or with the prior agreement of the Contractor) unless and until the Engineer has issued a Taking-Over Certificate for this part. However, if the Employer does use any part of the Works before the Taking-Over Certificate is issued the Contractor shall give a Notice to the Engineer identifying such part and describing such use, and:

- (d) that Part shall be deemed to have been taken over by the Employer as from the date on which it is used.
- (e) the Contractor shall cease to be liable for the care of such Part as from this date, when responsibility shall pass to the Employer; and
- (f) the Engineer shall immediately issue a Taking-Over Certificate for this Part, and any outstanding work to be completed (including Tests on Completion) and/or defects to be remedied shall be listed in this certificate.

After the Engineer has issued a Taking-Over Certificate for a Part, the Contractor shall be given the earliest opportunity to take such steps as may be necessary to carry out the outstanding work (including Tests on Completion) and/or remedial work for any defects listed in the certificate. The Contractor shall carry out these works as soon as practicable and, in any case, before the expiry date of the relevant Defects Notification Period (DNP).

If the Contractor incurs Cost as a result of the Employer taking over and/ or using a Part, the Contractor shall be entitled subject to payment of such Cost Plus Profit under *Claims For Payment and/or EOT*.

If the Engineer issues a Taking-Over Certificate for any part of the Works, or if the Employer is deemed to have taken over a Part under sub-paragraph (a) above, for any period of delay after the date under sub-paragraph (a) above, the Delay Damages for completion of the remainder of the Works shall be reduced. Similarly, the Delay Damages for the remainder of the Section (if any) in which this Part is included shall also be reduced. This reduction shall be calculated as the proportion which the value



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

of the Part (except the value of any outstanding works and/or defects to be remedied) bears to the value of the Works or Section (as the case may be) as a whole. The Engineer shall proceed under *Agreement or Determination* to agree or determine this reduction (and, for the purpose of *Time limits*, the date the Engineer receives the Contractor's Notice under this Sub-Clause shall be the date of commencement of the time limit for agreement. The provisions of this paragraph shall only apply to the daily rate of Delay Damages, and shall not affect the maximum amount of these damages.

C3.4. 27.3 Interference with Test on Completion

If the Contractor is prevented, for more than 14 days (either a continuous period, or multiple periods which total more than 14 days), from carrying out the Tests on Completion by the Employer's Personnel or by a cause for which the Employer is responsible (including any performance test that is not possible due to available operating conditions during trial operation):

- (a) the Contractor shall give a Notice to the Engineer describing such prevention.
- (b) the Employer shall be deemed to have taken over the Works or Section (as the case may be) on the date when the Tests on Completion would otherwise have been completed; and
- (c) the Engineer shall immediately issue a Taking-Over Certificate for the Works or Section (as the case may be).

After the Engineer has issued this Taking-Over Certificate, the Contractor shall carry out the Tests on Completion as soon as practicable and, in any case, before the expiry date of the Defects Notification Period (DNP). The Engineer shall give a Notice to the Contractor, of not less than 14 days, of the date after which the Contractor may carry out each of the Tests on Completion. Thereafter, Sub-Clause C3.4.26.11 [*Contractor's Obligations*] shall apply.

If the Contractor suffers delay and/or incurs Cost as a result of being prevented from carrying out the Tests on Completion, the Contractor shall be entitled subject to EOT and/or payment of such Cost Plus Profit.

C3.4. 27.4 Surfaces Requires Reinstatement

Except as otherwise stated in the Taking-Over Certificate, a certificate for a Section or Part of the Works shall not be deemed to certify completion of any ground or other surfaces requiring reinstatement.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.4. 28 Defects After Taking Over

C3.4. 28.1 Completion of Outstanding Work and Remedying Defects

In order that the Works and Contractor's Documents, and each Section and/ or Part, shall be in the condition required by the Contract (fair wear and tear excepted) by the expiry date of the relevant Defects Notification Period or as soon as practicable thereafter, the Contractor shall:

- (a) complete any work which is outstanding on the relevant Date of Completion, within the time(s) stated in the Taking-Over Certificate or such other reasonable time as is instructed by the Engineer; and
- (b) execute all work required to remedy defects or damage, of which a Notice is given to the Contractor by (or on behalf of) the Employer on or before the expiry date of the Defects Notification Period (DNP) for the Works or Section or Part (as the case may be).

If a defect appears or damage occurs during the relevant Defects Notification Period (DNP), a Notice shall be given to the Contractor accordingly, by (or on behalf of) the Employer. Promptly thereafter:

- (i) the Contractor and the Employer's Personnel shall jointly inspect the defect or damage.
- (ii) the Contractor shall then prepare and submit a proposal for necessary remedial work; and
- (iii) the second, third and fourth paragraphs of Sub-Clause 3.26.9 [Defects and Rejection] shall apply.

C3.4. 28.2 Cost Of Remedying Defects

All work under sub-paragraph (b) of Sub-Clause C3.4.28.1 [Completion of Outstanding Work and Remedying Defects] shall be executed at the risk and cost of the Contractor, if and to the extent that the work is attributable to:

- (a) the design of the Works, other than a part of the design for which the Employer is responsible (if any);
- (b) Plant, Materials or workmanship not being in accordance with the Contract.
- (c) improper operation or maintenance which was attributable to matters for which the Contractor is responsible (under Sub-Clause C35.11.7, C3.6.1.5 & C3.7.7 [Training], Sub-Clause C3.6.1.6 [As-Built Records] and/or Sub-Clause C3.6.1.7 [Operation and Maintenance Manuals] or otherwise); or
- (d) failure by the Contractor to comply with any other obligation under the Contract.

If the Contractor considers that the work is attributable to any other cause, the Contractor shall promptly give a Notice to the Engineer and the Engineer shall proceed to agree or determine the cause (and, for the purpose of the date of this Notice shall be the date of commencement of the time limit for agreement. If it is agreed or determined that the work is attributable



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

to a cause other than those listed above, *Variation by Instruction* shall apply as if such work had been instructed by the Engineer.

C3.4. 28.3 **Extension of Defects Notification Period**

The Employer shall be entitled to an extension of the DNP for the Works, or a Section or a Part:

- (a) if and to the extent that the Works, Section, Part or a major item of Plant (as the case may be, and after taking over) cannot be used for the intended purpose(s) by reason of a defect or damage which is attributable to any of the matters under sub-paragraphs (a) to (d) of Sub-Clause C3.4. 28.2 [*Cost of Remedying Defects*]; and
- (b) subject to *Claims For Payment and/or EOT*

However, a Defects Notification Period (DNP) shall not be extended by more than a period of two years after the expiry of the DNP stated in the Contract Data.

If delivery and/or erection of Plant and/or Materials was suspended (other than where the cause of such suspension is the responsibility of the Contractor), the Contractor's obligations under this Clause shall not apply to any defects or damage occurring more than two years after the DNP for the Works, of which the Plant and/or Materials form part, would otherwise have expired.

C3.4.28.4 **Failure to Remedy Defects**

If the remedying of any defect or damage under Sub-Clause C3.4.28.1 [*Completion of Outstanding Works and Remedying Defects*] is unduly delayed by the Contractor, a date may be fixed by (or on behalf of) the Employer, on or by which the defect or damage is to be remedied. A Notice of this fixed date shall be given to the Contractor by (or on behalf of) the Employer, which Notice shall allow the Contractor reasonable time (taking due regard of all relevant circumstances) to remedy the defect or damage.

If the Contractor fails to remedy the defect or damage by the date stated in this Notice and this remedial work was to be executed at the cost of the Contractor under Sub-Clause C3.4.28.2 [*Cost of Remedying Defects*], the Employer may (at the Employer's sole discretion):

- (a) carry out the work or have the work carried out by others (including any retesting), in the manner required under the Contract and at the Contractor's cost, but the Contractor shall have no responsibility for this work. The Employer shall be entitled subject to payment by the Contractor of the costs reasonably incurred by the Employer in remedying the defect or damage;
- (b) accept the damaged or defective work, in which case the Employer shall be entitled subject to *Claim For Payment* to:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- (i) payment of Performance Damages by the Contractor in full satisfaction of this failure; or
- (ii) if there is no Schedule of Performance Guarantees under the Contract, or no applicable Performance Damages, a reduction in the Contract Price. The reduction shall be in full satisfaction of this failure only and shall be in the amount as shall be appropriate to cover the reduced value to the Employer as a result of this failure;
- (c) require the Engineer to treat any part of the Works which cannot be used for its intended purpose(s) under the Contract by reason of this failure as an omission, as if such omission had been instructed under *Variation by Instruction*; or
- (d) terminate the Contract as a whole with immediate effect (and *Termination for Contractor's Default* shall not apply) if the defect or damage deprives the Employer of substantially the whole benefit of the Works. The Employer shall then be entitled subject to *Claim For Payment* to recover from the Contractor all sums paid for the Works, plus financing charges and any costs incurred in dismantling the same, clearing the Site and returning Plant and Materials to the Contractor.

The exercise of discretion by the Employer under sub-paragraph (c) or (d) above shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

C3.4. 28.5 Remedying of Defective Work off Site

If, during the DNP, the Contractor considers that any defect or damage in any Plant cannot be remedied expeditiously on the Site the Contractor shall give a Notice, with reasons, to the Employer requesting consent to remove the defective or damaged Plant off the Site for the purposes of repair. This Notice shall clearly identify each item of defective or damaged Plant, and shall give details of:

- (a) the defect or damage to be repaired.
- (b) the place to which defective or damaged Plant is to be taken for repair.
- (c) the transportation to be used (and insurance cover for such transportation);
- (d) the proposed inspections and testing off the Site.
- (e) the planned duration required before the repaired Plant shall be returned to the Site; and
- (f) the planned duration for reinstallation and retesting of the repaired Plant (under PS 3.26.8 [Testing by the Contractor] and/or Clause C3.4.26.11 to C3.4.26.14 [Tests on Completion] if applicable).

The Contractor shall also provide any further details that the Employer may reasonably require.

When the Employer gives consent (which consent shall not relieve the Contractor from any obligation or responsibility under this Clause), the Contractor may remove from the Site such items of Plant as

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

are defective or damaged. As a condition of this consent, the Employer may require the Contractor to increase the amount of the Performance Security by the full replacement cost of the defective or damaged Plant.

C3.4. 28.6 Further Tests after Remedying Defects

Within 7 days of completion of the work of remedying of any defect or damage, the Contractor shall give a Notice to the Engineer describing the remedied Works, Section, Part and/or Plant and the proposed repeated tests (under Clause C3.4.26.11 to C3.4.26.14 [*Tests on Completion*] or Clause C3.4.29 [*Tests after Completion*], as applicable).

Within 7 days after receiving this Contractor's Notice, the Engineer shall give a Notice to the Contractor either:

- (a) agreeing with such proposed testing; or
- (b) instructing the repeated tests that are necessary to demonstrate that the remedied Works, Section, Part and/or Plant comply with the Contract.

If the Contractor fails to give such a Notice within the 7 days, the Engineer may give a Notice to the Contractor, within 14 days after the defect or damage is remedied, instructing the repeated tests that are necessary to demonstrate that the remedied Works, Section, Part and/or Plant comply with the Contract.

All repeated tests under this Sub-Clause shall be carried out in accordance with the terms applicable to the previous tests, except that they shall be carried out at the risk and cost of the Party liable, under Sub-Clause PS 3. 28.2 [*Cost of Remedying Defects*], for the cost of the remedial work.

C3.4. 28.7 Right of Access after Taking Over

Until the date 28 days after issue of the Performance Certificate, the Contractor shall have the right of access to all parts of the Works and to records of the operation, maintenance and performance of the Works, except as may be inconsistent with the Employer's reasonable security restrictions.

Whenever the Contractor intends to access any part of the Works or such records during the relevant DNP:

- (a) the Contractor shall request access by giving a Notice to the Employer, describing the parts of the Works and/or records to be accessed, the reasons for such access, and the Contractor's preferred date for access. This Notice shall be given in reasonable time in advance of the preferred date for access, taking due regard of all relevant circumstances including the Employer's security restrictions; and



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(b) within 7 days after receiving the Contractor's Notice, the Employer shall give a Notice to the Contractor either:

- (i) stating the Employer's consent to the Contractor's request; or
- (ii) proposing reasonable alternative date(s), with reasons. If the Employer fails to give this Notice within the 7 days, the Employer shall be deemed to have given consent to the Contractor's access on the preferred date stated in the Contractor's Notice.

If the Contractor incurs additional Cost as a result of any unreasonable delay by the Employer in permitting access to the Works or such records by the Contractor, the Contractor shall be entitled subject to [Claims For Payment and/or EOT] payment of any such Cost Plus Profit.

C3.4. 28.8 Contractor to Search

The Contractor shall, if instructed by the Engineer, search for the cause of any defect, under the direction of the Engineer. The Contractor shall carry out the search on the date(s) stated in the Engineer's instruction or other date(s) agreed with the Engineer.

Unless the defect is to be remedied at the cost of the Contractor under Sub-Clause C3.4.28.2 [Cost of Remedying Defects], the Contractor shall be entitled subject to [Claims For Payment and/or EOT] to payment of the Cost Plus Profit of the search.

If the Contractor fails to carry out the search in accordance with this Sub-Clause, the search may be carried out by the Employer's Personnel. The Contractor shall be given a Notice of the date when such a search will be carried out and the Contractor may attend at the Contractor's own cost. If the defect is to be remedied at the cost of the Contractor under Sub-Clause C3.4.28.2 [Cost of Remedying Defects], the Employer shall be entitled subject to [Claims For Payment and/or EOT] to payment by the Contractor of the costs of the search reasonably incurred by the Employer.

C3.4. 28.9 Performance Certificate

Performance of the Contractor's obligations under the Contract shall not be considered to have been completed until the Engineer has issued the Performance Certificate to the Contractor, stating the date on which the Contractor fulfilled the Contractor's obligations under the Contract.

The Engineer shall issue the Performance Certificate to the Contractor (with a copy to the Employer and to the DAAB) within 28 days after the latest of the expiry dates of the Defects Notification Periods, or as soon thereafter as the Contractor has:

- (a) supplied all the Contractor's Documents, and the Engineer has given (or is deemed to have given) a Notice of No-objection to the as-built records under sub-paragraph (b) of Sub-Clause C3.6.1.6 [As-Built Records]; and

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- (b) completed and tested all the Works (including remedying any defects) in accordance with the Contract.

If the Engineer fails to issue the Performance Certificate within this period of 28 days, the Performance Certificate shall be deemed to have been issued on the date 28 days after the date on which it should have been issued, as required by this Sub-Clause.

Only the Performance Certificate shall be deemed to constitute acceptance of the Works.

C3.4. 28.10 Unfulfilled Obligations

After the issue of the Performance Certificate, each Party shall remain liable for the fulfilment of any obligation which remains unperformed at that time. For the purposes of determining the nature and extent of unperformed obligations, the Contract shall be deemed to remain in force.

However, in relation to Plant, the Contractor shall not be liable for any defects or damage occurring more than two years after expiry of the DNP for the Plant except if prohibited by law or in any case of fraud, gross negligence, deliberate default or reckless misconduct.

C3.4. 28.11 Clearance of Site

Promptly after the issue of the Performance Certificate, the Contractor shall:

- (a) remove any remaining Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works from the Site;
- (b) reinstate all parts of the Site which were affected by the Contractor's activities during the execution of the Works and are not occupied by the Permanent Works; and
- (c) leave the Site and the Works in the condition stated in the Employer's Requirements (if not stated, in a clean and safe condition).

If the Contractor fails to comply with sub-paragraphs (a), (b) and/or (c) above within 28 days after the issue of the Performance Certificate, the Employer may sell (to the extent permitted by applicable Laws) or otherwise dispose of any remaining items and/or may reinstate and clean the Site (as may be necessary) at the Contractor's cost.

The Employer shall be entitled subject [to *Claims For Payment*] to payment by the Contractor of the costs reasonably incurred in connection with, or attributable to, such sale or disposal and reinstating and/or cleaning the Site, less an amount equal to the moneys from the sale (if any).

C3.4. 29 Tests After Completion

C3.4. 29.1 Procedure for Tests after Completion

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If Tests after Completion are specified in the Employer's Requirements, this Clause shall apply. The Employer shall:

- (a) provide all electricity, water, sewage (if applicable), equipment, fuel, consumables, instruments, labour, materials, and suitably qualified, experienced and competent staff, as are necessary to carry out the Tests after Completion efficiently and properly; and
- (b) carry out the Tests after Completion in accordance with:
 - (i) the Employer's Requirements,
 - (ii) the O&M Manuals to which the Engineer has given (or is deemed to have been given) a Notice of No-objection, under Sub-Clause C3.6.1.7 [*Operation and Maintenance Manuals*], and
 - (iii) such guidance as the Contractor may be required to give during the course of these tests; and

in the presence of such Contractor's Personnel as either Party may reasonably request.

The timing of the Tests after Completion shall be as stated in the Employer's Requirements (if not stated, as soon as is reasonably practicable) after the Works or Section (as the case may be) have been taken over under Clause C3.4.27 [*Employer's Taking Over*]. The Engineer shall give a Notice to the Contractor, of not less than 21 days, of the date on which and place at which the Tests after Completion will be carried out. This Notice shall also include a test programme showing the estimated timing for each of such tests. Unless otherwise agreed with the Contractor, these tests shall be carried out on this date.

If the Contractor does not attend at the time and place stated in the Engineer's Notice (or otherwise agreed with the Contractor), the Employer may proceed with the Tests after Completion, which shall be deemed to have been made in the Contractor's presence, and the Contractor shall be deemed to have accepted the readings as accurate.

The results of the Tests after Completion shall be compiled and evaluated by both Parties. Appropriate account shall be taken of the effect of the Employer's prior use of the Works.

C3.4. 29.2 Delayed Tests

If the Contractor incurs Cost as a result of any unreasonable delay by the Employer in carrying out the Tests after Completion, the Contractor shall be entitled subject to payment of such Cost Plus Profit under *Claims For Payment and/or EOT*.

If, for reasons not attributable to the Contractor, a Sub-Clause C3.4.29 -Test after Completion on the Works or any Section cannot be completed during the DNP (or any other period agreed by both Parties), then the Works or Section shall be deemed to have passed this Sub-Clause C3.4.29 Test after Completion.



Contractor



Witness 1



Witness 2



Employer



Witness 1



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C3.4. 29.3 Retesting

Subject to Sub-Clause C3.4.29.4 [*Failure to Pass Tests after Completion*], if the Works, or a Section, fail to pass the Tests after Completion:

- (a) sub-paragraph (b) of Sub-Clause C3.4.28.1 [*Completion of Outstanding Work and Remedying Defects*] shall apply; and
- (b) after remedying any defect or damage, Sub-Clause C3.4.28.6 [*Further Tests after Remedying Defects*] shall apply.

If and to the extent that this failure and retesting are attributable to any of the matters listed in sub-paragraphs (a) to (d) of Sub-Clause C3.4.28.2 [*Cost of Remedying Defects*] and cause the Employer to incur additional costs, the Employer shall be entitled subject to *Claims For Payment* of these costs by the Contractor.

C3.4. 29.4 Failure to Pass Tests after Completion

If:

- (a) the Works, or a Section, fail to pass any or all of the Tests after Completion; and
- (b) applicable Performance Damages are set out in the Schedule of Performance Guarantees

the Employer shall be entitled subject to *Claims For Payment* of these Performance Damages by the Contractor in full satisfaction of this failure. If the Contractor pays these Performance Damages to the Employer during the DNP, then the Works or Section shall be deemed to have passed these Tests after Completion.

If the Works, or a Section, fail to pass a Sub-Clause C3.4.29 Test after Completion and, by giving a Notice to the Employer, the Contractor proposes to make adjustments or modifications to the Works or such Section (including an item of Plant):

- a. the Contractor may be instructed by a Notice given by the Employer that right of access to the Works or Section cannot be given until a time that is convenient to the Employer, which time shall be reasonable;
- b. the Contractor shall remain liable to carry out the adjustments or modifications and to satisfy this Test, within a reasonable period of receiving the Notice under sub-paragraph (i) above; and
- c. if the Contractor does not receive a Notice under sub-paragraph (i) above during the relevant DNP, the Contractor shall be relieved of the obligation to make such adjustments or modifications and the Works or Section (as the case may be) shall be deemed to have passed this Sub-Clause C3.4.29 Test after Completion.



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Witness 2



Employer



Witness 1



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If the Contractor incurs additional Cost as a result of any unreasonable delay by the Employer in permitting access to the Works or Section by the Contractor, either to investigate the causes of a failure to pass a Sub-Clause C3.4.29 -Test after Completion or to carry out any adjustments or modifications, the Contractor shall be entitled subject to *Claims For Payment and/or EOT*] of any such Cost Plus Profit.

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C3.5 MANAGEMENT

C3.5.1 Meetings

- a) The Contractor shall attend the following meetings during the Contract:
- b) An inaugural meeting within two weeks of the Commencement Date, or as called by the Engineer. This meeting will take place at the office of the Employer, or as otherwise advised by the Engineer.
- c) Monthly Progress Site Meetings, on Site or as called by the Engineer, from the order to commence the Works until the issue of the Completion Certificate.
- d) Ad hoc meetings called by the Engineer to discuss programming and coordination with other contractors.
- e) A HAZOP study.
- f) Design workshops as specified elsewhere.
- g) Other meetings to discuss and agree on technical details specified elsewhere or as called by the Engineer
- h) Quarterly meetings during the Defects Notification Period as called by the Engineer –at the Engineer's offices in Polokwane, or on Site.

If the Contractor is not able to attend, apologies shall be provided 48 hours in advance. A representative of the main Contractor, shall be present in all the meetings listed c) to g).

C3.5.1.1 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.

C3.5.1.2 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

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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.

C3.5.2 Programme of Works

C3.5.2.1 Planning of Works

The Contractor shall ensure that:

- a) 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
- b) compiles designs, documentation, reports and drawings timeously as not to unnecessarily delay the implementation of the construction or investigative projects.
- c) The programme shall at minimum contain the following:
- d) Time Scale (minimum): Days, where the project period does not exceed three months. Weeks, where the project period exceeds three months.
- e) Time Scale (maximum): Months, where the project period does not exceed one year. Years, where the project period exceeds one year.
- f) 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 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

C3.5.2.2 Initial Programme

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The Contractor shall submit an initial programme for the execution of the Works to the Engineer within 28 days after receiving the Notice under Sub-Clause [Commencement of Works]. This programme shall be prepared using programming software stated in the Employer's Requirements (if not stated, the programming software acceptable to the Engineer). The Contractor shall also submit a revised programme which accurately reflects the actual progress of the Works, whenever any programme ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations.

The initial programme and each revised programme shall be submitted to the Engineer in one paper copy, one electronic copy and additional paper copies (if any) as stated in the Contract Data, and shall include:

- a) the Commencement Date and the Time for Completion, of the Works and of each Section (if any);
- b) the date right of access to and possession of (each part of) the Site is to be given to the Contractor in accordance with the time (or times) stated in the Contract Data. If not so stated, the dates the Contractor requires the Employer to give right of access to and possession of (each part of) the Site;
- c) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design, preparation and submission of Contractor's Documents, procurement, manufacture, inspection, delivery to Site, construction, erection, installation, work to be undertaken by any nominated Subcontractor, testing, commissioning and trial operation.
- d) the Review periods under Sub-Clause C3.6.1.2 [Review by Engineer], and periods for Review for any other submissions specified in the Employer's Requirements or required under these Conditions.
- e) the sequence and timing of inspections and tests specified in, or required by, the Contract.
- f) for a revised programme: the sequence and timing of the remedial work (if any) to which the Engineer has given a Notice of No-objection under Sub-Clause [Defects and Rejection] and/or the remedial work (if any) instructed under Sub-Clause 7.6 [Remedial Work].
- g) all activities (to the level of detail specified in the Employer's Requirements), logically linked and showing the earliest and latest start and finish dates for each activity, the float (if any), and the critical path(s).
- h) the dates of all locally recognised days of rest and holiday periods (if any).
- i) all key delivery dates of Plant and Materials.
- j) for a revised programme and for each activity: the actual progress to date, any delay to such progress and the effects of such delay on other activities (if any); and
- k) a supporting report which includes:
 - i) a description of all the major stages of the execution of the Works.



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Witness 2



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Witness 1



Witness 2

- ii) a general description of the methods which the Contractor intends to adopt in the execution of the Works.
- iii) details showing the Contractor's reasonable estimate of the number of each class of Contractor's Personnel, and of each type of Contractor's Equipment, required on the Site, for each major stage of the execution of the Works.
- iv) if a revised programme, identification of any significant change(s) to the previous programme submitted by the Contractor; and
- v) the Contractor's proposals to overcome the effects of any delay(s) on progress of the Works.

The Engineer shall Review the initial programme and each revised programme submitted by the Contractor and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract or ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations. If the Engineer gives no such Notice:

- within 21 days after receiving the initial programme; or
- within 14 days after receiving a revised programme,

the Engineer shall be deemed to have given a Notice of No-objection and the initial programme or revised programme (as the case may be) shall be the Programme.

The Contractor shall proceed in accordance with the Programme, subject to the Contractor's other obligations under the Contract. The Employer's Personnel shall be entitled to rely on the Programme when planning their activities.

Nothing in any programme, the Programme or any supporting report shall be taken as, or relieve the Contractor from any obligation to give, a Notice under the Contract.

If, at any time, the Engineer gives a Notice to the Contractor that the Programme fails (to the extent stated) to comply with the Contract or ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations, the Contractor shall within 14 days after receiving this Notice submit a revised programme to the Engineer in accordance with this Sub-Clause.

C3.5.2.3 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

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all times on site and that at least one member of the permanent site staff is competent on their operation.

C3.5.2.4 Detail to be Shown on Programme

The Contractor's programme, required in terms of the Contract Data, shall be in a bar

- a) chart form (Gantt Chart), and shall show:
- b) The various activities, related to a time scale, for each element of the Works, including those of Nominated and/or Subcontractors, in sufficient detail to be able to assess construction progress. Dates for submission (by the Contractor) of designs and or design documents.
- c) Dates for ordering of special and/or long delivery items.
- d) Dates for issue of or approval of drawings for planning purposes.
- e) Dates for issue of or approval of drawings for manufacture and construction purposes requiring the approval of the Engineer.
- f) Critical path activities and their dependencies.
- g) Dates for the placement of orders for material, receipt of material, fabrication and manufacture, works (factory) testing, shipment, erection and commissioning.
- h) Dates showing start and completion of site construction of each section and each major component of the permanent works.
- i) Dates showing the delivery of all built-in steelwork, anchor bolts, etc.
- j) Dates for start and completion of Engineering Design (including allowances for review/approval by the Engineer).
- k) Dates for submittal and acceptance of drawings.
- l) Dates for submittal of operation and maintenance manuals.
- m) Dates for submittal of commissioning check lists and detailed commissioning schedules for acceptance (3 months before the commencement of commissioning).
- n) Dates for submittal of commissioning check lists and detailed schedules of approval (3 months before the commencement of commissioning).
- o) Dates for submission of complete schedules for all manufactured items.
- p) Dates for Test on Completion as defined in the Contract Data.
- q) For the Civil Works, the date on which each structure is ready for:
 - i. Installation of Mechanical and Electrical Works equipment
 - ii. Testing and commissioning of Mechanical and electrical Works equipment.
- r) For the Mechanical and Electrical Works – Pump Station the Contractor shall allow for a period of three weeks for examination by the Engineer of each submission of the designs, drawings or other details submitted by the Contractor for acceptance by the Engineer. This applies to each submission required by the Engineer until the Contractor has submitted designs and drawings which comply with the Specification and are approved by the Engineer

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- s) Other key dates in respect of work to be carried out by others, such as connection to pipelines provided by others.
- t) Key dates in respect of information to be provided by the Engineer and/or others, including reasonable and justifiable dates by when drawings detailing reinforcement bending schedules for major components of each of the concrete structures are required.
- u) Submission of the documentation required in terms of Clause 5.3.1 of the General Conditions of Contract

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.

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

C3.5.2.5 General Allowances

When drawing up his programme in terms of C1.2: Contract Data and PS4.2.1, the Contractor shall, take into consideration and make allowance for, inter alia:

- a) Expected weather conditions and their effects
- b) Known physical conditions or artificial obstructions
- c) Searching for, dealing with and carrying out alterations to the existing services
- d) The accommodation of public access and traffic
- e) The provision and implementation of the health and safety plan in terms of the 2014 Construction Regulations, 1993 of the Occupational Health and Safety Act
- f) The design, testing and approval of the concrete mixes
- g) Selective methods of excavation and shoring thereof
- h) The restricted working areas
- i) The requirements and programmes of those responsible for the work carried out by others.
- j) The environmental requirements as specified in the Environmental Management Specification.



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- k) The time required for the Employer's designers to attend to amendments or further
- l) detailing (e.g. for plinth reinforcement) to the Design by the Employer and associated
- m) drawings, where such amendments are required to accommodate the Mechanical and
- n) Electrical Works.

C3.5.2.6 Updating of Programme

The Contractor shall review his progress each month and should progress lag behind the latest accepted programme, by more than 4 weeks, he shall submit a revised programme and method statement of how he proposes to make up the lost time. If, in the opinion of the Engineer, such revised programme will not make up the lost time, the Engineer shall have the right to request the Contractor to reorganize his work in a manner which will ensure an acceptable programme. Claims for additional payment to meet any costs incurred due to such reorganisation will not be accepted.

If any change to the critical path occurs, the Contractor shall as soon as practical notify the Engineer in writing.

C3.5.2.7 Programme as a Basis for Claims

The Contractor's programme and method statements will not be accepted as the basis for claims for extension of time and/or additional compensation without due reference to all relevant associated factors, and without demonstrating that a delay to the critical path activities has resulted.

C3.5.2.8 Document Format

Programmes shall be submitted in Microsoft Project format in hardcopy and softcopy. Progress claims shall be in Microsoft Excel in accordance with the standard template provided by the Engineer.

C3.5.2.9 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:

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- 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.

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

C3.5.2.10 Progress & Monthly Reporting

Monthly progress reports, in the format stated in the Employer's Requirements (if not stated, in a format acceptable to the Engineer), shall be prepared by the Contractor and submitted to the Engineer. Each progress report shall be submitted in 4 sets of paper-original, one electronic copy and additional paper copies (if any) as stated in the Contract Data. The first report shall cover the period up to the end of the first month following the Commencement Date.

Reports shall be submitted monthly thereafter, each within 7 days after the last day of the month to which it relates. The Contractor shall submit a comprehensive progress report at least 72 hours prior to each Site Progress Meeting. Reporting shall continue until the Date of Completion of the Works or, if outstanding work is listed in the Taking-Over Certificate, the date on which such outstanding work is completed. Unless otherwise stated in the Employer's Requirements, each progress report shall include

- a) Charts, diagrams and detailed descriptions of progress, including each stage of design, Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection, testing, commissioning and trial operation.
- a) Photographs and/or video recordings showing the detailed descriptions of progress, including each stage of design (if applicable), procurement, status of manufacture and of progress on and off the Site, delivery to the Site, construction, erection, testing and commissioning.
- b) For the manufacture of each main item of Plant and Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- (i) commencement of manufacture,
 - (ii) Contractor's inspections,
 - (iii) tests, and
 - (iv) shipment and arrival at the Site.
- c) The details described as *Contractor's Records*, as follows: Unless otherwise proposed by the Contractor and agreed by the Engineer, in each progress report under Sub-Clause C3.5.2.10 [Progress Reports], the Contractor shall include records of:
 - (i) occupations and actual working hours of each class of Contractor's Personnel.
 - (ii) the type and actual working hours of each of the Contractor's Equipment.
 - (iii) the types of Temporary Works used.
 - (iv) the types of Plant installed in the Permanent Works; and
 - (v) the quantities and types of Materials usedfor each work activity shown in the Programme, at each work location and for each day of work.
- d) Copies of quality management documents, inspection reports, test results, and compliance verification documentation (including certificates of Materials).
- e) Updated Contractor's Document Register with list and statistics of construction daily documents which are completed/reviewed by Engineer and outstanding/awaiting review, response & approval by Engineer such as: Field Engineering Queries, Detailed Design Drawings, Method Statements, Request For Information, Site Instructions, etc.
- f) A list of Variations, and any Notices given (by either Party) under Notice of Claim.
- g) Occupational Health & Safety and Environmental detailed reports statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations. This shall include summary of all health and safety matters on site such as identifying and assessment of risks, reporting of incidents, injuries, near-misses and providing mitigation measures to all known risks
- h) Comparisons of actual and planned progress, with details of any events or circumstances which may adversely affect the completion of the Works in accordance with the Programme and the Time for Completion, and the measures being (or to be) adopted to overcome delays.
- i) Approved programme indicating the actual versus scheduled progress for each item on the programme, the aggregate progress and including the "time now" line.
- j) Charts showing the status of construction documents, drawings, purchase orders, manufacture and construction.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- k) 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.
- l) Records of personnel and Contractor's equipment on the Site.
- m) A written summary of the progress to date.
- n) Financial status of contract and updated realistic cash flows.
- o) Any delays encountered or anticipated.
- p) An information required schedule indicating any information or drawings required.
- q) Plant and Labour Report; and
- r) Subcontractor/s progress.

However, nothing stated in any progress report shall constitute a Notice under a Sub-Clause of these Conditions.

C3.5.2.11 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).

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.5.3 Methods and Procedures

When requested by the Engineer or as required in terms of the Health and Safety or Environmental regulations or specifications, the Contractor shall submit within 2 weeks (14 days) of date of such written request or otherwise at least 2 weeks (14 days) prior to when the particular activity is planned to commence, whichever time is the soonest, a method statement detailing the Contractor's proposed construction procedure of certain elements of the Works.

No work shall commence before the method statement has been submitted and approved. The approval shall not relieve the Contractor from his responsibilities in terms of the Contract.

C3.5.4 Format of Communications

All contractual communications shall be in writing.

Any request for inspections by the Engineer shall be submitted to the Engineer in good time, being conscious of the complexity nature of the inspection in conjunction with the logistics for the Engineer to perform such an inspection and that sufficient notice to be provided in accordingly to inspect such Works

C3.5.5 Key Personnel

The key personnel assigned to the Contractor's team shall as a minimum be as proposed by the Contractor in the tender offer. These staff shall not be replaced without the written permission of the Engineer. Should any of the staff at any time not be available for full-time assignment to the Contract, the Contractor shall submit the details of an alternative person with equivalent or better qualifications and experience to the Engineer for approval.

C3.5.6 Monthly Labour Returns

The Contractor shall submit with each statement for payment a labour return showing the Number of Person Days and Labour Days recorded for the Contract. The returns shall be similar to the format approved by the Engineer.

C3.5.7 Bonds and Guarantees

The form of guarantee is to be delivered to the Engineer, within the time period stated in the Contract Data and shall be in the format as provided in the Contract Data.

C3.5.8 Payment Certificates

The statement to be submitted by the Contractor in terms of Clause 6.10 of the General Conditions of Contract shall be prepared in accordance with the standard payment certificate prescribed by the Engineer and shall be provided electronically in Microsoft.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Excel format. All costs incurred by the Contractor resulting from the preparation and submission of the statements shall be borne by the Contractor.

For the purposes of the Engineer's payment certificate, the Contractor shall subsequently be responsible, at his own cost, for making such adjustments to his statement as may be required by the Engineer for the purposes of accurately reflecting the actual quantities and amounts which the Engineer deems to be due and payable to the Contractor in the payment certificate.

The Contractor shall, at his own cost, make the said adjustments to the statement and return it to the Engineer within three (3) normal workings days from the date on which the Engineer communicated to the Contractor the adjustments required.

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

C3.5.9 Occupational Health And Safety

C3.5.9.1 General Statement

The Contractor shall comply with the requirements of the Project Health and Safety Specification included.

The Contractor shall provide a safe and healthy working environment and shall direct activities in such a manner that employees and any other persons, who may be directly affected by these activities, are not exposed to hazards to their health and safety.

The Contractor shall comply with the Occupational Health and Safety Act (Act No. 85 of 1993) (OHS Act) and Amendment Act No 181 of 1993, and the Regulations. The 2014 Construction Regulations are applicable to this Contract.

For the purpose of this Contract, the Contractor is required to sign confirmation of status as mandatory and employer for the execution of the Contract by entering into an agreement with the Employer in terms of the Occupational Health and Safety Act by executing the Occupational Health and Safety Agreement form included in Part C1: Agreements and Contract Data.

C3.5.9.2 Appropriate Supervision and Equipment

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All work shall be supervised and overseen by competent persons.

The Contractor shall ensure that adequate ventilation, lighting, scaffolding, ladders, lifting devices and safety harnesses and the like are provided as appropriate for each activity.

C3.5.9.3 **Employer Health and Safety Requirements and Procedures**

In terms of the provisions of Section 37(2) of the Occupational Health and Safety Amendment Act, 1993 (Act 85 of 1993) hereinafter referred to as the Act, the following arrangements and procedures shall apply between the Contractor and the Employer to ensure compliance by the Contractor with the provisions of the Act:

- a) The Contractor undertakes to acquaint the appropriate officials and employees of the Contractor with all relevant provisions of the Act and the Regulations promulgated in terms of the Act.
- b) The Contractor undertakes that all relevant duties, obligations and prohibitions imposed in terms of the Act and Regulations on the Contractor will be fully complied with.
- c) The Contractor accepts sole liability for such due compliance with the relevant duties, obligations and prohibitions imposed by the Act and Regulations and expressly absolves the Employer from himself being obliged to comply with any of the aforesaid duties, obligations and prohibitions, with the exception of such duties, obligations and prohibitions expressly assigned to the Employer in terms of the Act and its associated Regulations
- d) The Contractor agrees that any duly authorised officials of the Employer shall be entitled, although not obliged, to take such steps as may be necessary to monitor that the Contractor has conformed to his undertakings as described in paragraphs (a) and (b) above, which steps may include, but will not be limited to, the right to inspect any appropriate site or premises occupied by the Contractor, or any appropriate records or safety plans held by the Contractor.
- e) The Contractor shall be obliged to report forthwith to the Employer and Engineer any investigation, complaint or criminal charge which may arise as a consequence of the provisions of the Act and Regulations, pursuant to work performed in terms of this Contract, and shall, on written demand, provide full details in writing, to the Employer and Engineer, of such investigation, complaint or criminal charge.
- f) The Contractor shall furthermore, in compliance with Constructional Regulations, acquaint himself with the requirements of the Employer's health and safety specification as laid down in regulation 5(1)(b) of the Construction Regulation, and prepare a suitably and sufficiently documented health and safety plan as contemplated in regulation 7(1) of the Construction Regulation for approval by the Employer or his assigned agent. The Contractor's health and safety plan and risk assessment shall be submitted for approval, to the Employer or his agent, within 14 days of the Commencement Date and shall be implemented and maintained from the commencement of the Works. The Contractor shall at all times be responsible for full



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

compliance with the approved plan as well as with the Construction Regulations and no extension of time will be considered for delays due to non-compliance with the abovementioned plan or regulations.

- g) The Employer, or his assigned agent, reserves the right to conduct periodic audits, as contemplated in the Construction Regulations, to monitor that the Contractor is compliant in respect of his obligations. Failure by the Contractor to comply with the requirements of these Regulations shall entitle the Engineer, at the request of the Employer or his agent, to suspend all or any part of the Works, with no recourse whatsoever by the Contractor for any damages incurred as a result of such suspension, until such time that the Employer or his agents are satisfied that the issues in which the Contractor has been in default have been rectified.
- h) The proposed type of work, materials to be used and potential hazards likely to be encountered on this Contract are detailed throughout the Project Specifications and the Employers' health and safety specification in Part C3.4: Particular Specifications.

C3.5.9.4 Protection of the Public and Employer's Staff

The Contractor shall at all times ensure that his operations do not endanger any member of the public, or any municipal staff working on, or visiting the Site. The Contractor shall take special precautions to prevent public access to any danger areas on the Works, e.g. by temporary barricades and/or fencing. The Contractor shall maintain barricades and/or fencing for the duration of the Contract.

C3.5.9.5 Specific Risks and Hazards

The Contractor shall be aware of and shall identify the risks and hazards associated with the execution of the Works.

The specific risks and hazards listed below have been identified and the Contractor shall allow for these and expand upon them in preparing and maintaining the required Health and Safety Plan:

- a) Handling of heavy mechanical and electrical equipment.
- b) Handling of heavy objects.
- c) Installation of equipment with limited access.
- d) Working at heights.
- e) Working on slippery surfaces.
- f) Falling of heavy items and equipment
- g) Drowning in water retaining structures and chambers.
- h) Work in confined spaces and deep trenches.
- i) Handling and using of explosives
- j) Handling and working with and in the vicinity of live electrical equipment and cables of various voltages.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- k) Handling and working with and in the vicinity of operating equipment, including rotating equipment such as pumps.
- l) Possible exposure to liquid, gas and dust forms of chemicals to be handled, stored and dosed on the Site, such as chlorine gas, calcium hypochlorite, chlorinated water, limestone, soda ash, caustic soda, aluminium sulphate, other coagulants and water treatment polymers.
- m) Possible exposure to residual solids (silt/sludge) generated in the water treatment process on Site.
- n) Snakes and poisonous insects.
- o) The Contractor being on Site for measuring, installation, testing or commissioning activities whilst construction by others is ongoing.
- p) Construction activities carried out by others on Site.

C3.5.9.6 Contractor's Health and Safety Plan

The Contractor shall submit a Health and Safety Plan tailored for the execution of the work under the Contract and in accordance with the Employer's Health and Safety Specification. The Contractor's Health and Safety Plan shall be submitted to the Employer for approval. The Contractor shall not access the Site before the Employer has approved the Health and Safety Plan in writing. Time lost due to delayed access to Site or suspension of the work as a result of the Contractor's failure to submit the safety plan timeously, shall not be used as a reason to claim for extension of time or standing time and related costs.

The Health and Safety Plan shall at least cover the following:

- a) A proper risk assessment of the Works, risk items, work methods and procedures in terms of Regulations 9 to 30 of the Construction Regulations.
- b) Identification of potential hazards and unsafe working conditions.
- c) Provision of a safe working environment and equipment.
- d) Statements of methods to ensure the health and safety of Sub-Contractors, employees and visitors to the site, including safety training in hazards and risk areas (Regulation 7 of the Construction Regulations).
- e) Monitoring health and safety on the site of works on a regular basis, and keeping of records and registers as provided for in the Construction Regulations.
- f) Details of the key personnel to be appointed for the work on Site in terms of Regulation 8 and other applicable regulations.
- g) Details of methods to ensure that the Health and Safety Plan will be carried out effectively in accordance with the Construction Regulations.

The Contractor's Health and Safety Plan will be subject to approval by the Employer, or amendment if necessary, before commencement of construction work. The Contractor will not be allowed to


Contractor


Witness 1


Witness 2


Employer


Witness 1


Witness 2

commence work, or his work will be suspended if he has already commenced work, before he has obtained the Employer's written approval of his Health and Safety Plan.

Time lost due to delayed commencement or suspension of the work as a result of the Contractor's failure to obtain approval for his safety plan, shall not be used as a reason to claim for extension of time or standing time and related costs.

C3.5.9.7 Health of Contractors Staff

The following parts of SANS 1921 Construction and management requirements for works contracts and associated specification data are applicable:

SANS 1921-6 HIV/AIDS Awareness

The associated amendments are as follows:

Sub-clause 4.2.1: The Contractor shall submit the details of qualified service providers to the Engineer for approval. The service provider shall be recognised by the South African Department of Health as a specialist.

Sub-clause 4.2.1: The HIV/AIDS awareness programme is to be repeated at four-month intervals throughout the duration of the contract, but limited to a maximum of six times, including the initial one at the start of the contract.

C3.5.9.8 Cost of Compliance Occupational Health and Safety Requirements

The Contractor's tendered rates shall be deemed to include all costs for conforming to the requirements of this Contract in terms of Occupational Health and Safety, including those of the Act, the Regulations and the Employer's Health and Safety Specification.

C3.5.9.9 Penalties for Non-Conformance/Non-Compliance

Should the Contractor fail to comply with the provisions of the Regulations, the Contractor will be liable for penalties as provided for in C1.2: Contract Data.

C3.5.10 Environmental Management

C3.5.10.1 General

The Contractor shall comply with the requirements of the Environmental Management Plan included.

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



Contractor



Witness 1



Witness 2



Employer



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Witness 2

in any manner by his acts or neglect, or his agents, employees, or workmen in the execution of the works.

C3.5.10.2 **Cost of Compliance with Environmental Management Requirements**

The Contractor's tendered rates shall be deemed to include all costs for conforming to the requirements of this Contract in terms of environmental management.

C3.5.11 Targeted Labour and Enterprise Contract Participation

C3.5.11.1 **General**

In support of the National Department of Public Works' Expanded Public Works Programme which is aimed at alleviating poverty through the creation of temporary employment opportunities using local labour and business to support the local community.

It is a requirement of this Contract, therefore, that the work be executed in such a manner so as to maximise the use of local labour and business enterprise.

To this end, a minimum combined targeted labour and enterprise contract participation goal is specified below, which shall be achieved by the Contractor in the performance of the Works, failing which, penalties as described will be applied.

The combined targeted labour and enterprise contract participation goal = 30%, whilst the targeted labour contract participation goal shall achieve a minimum percentage goal of 5%.

C3.5.11.2 **Definitions**

For the purposes of the requirements in respect of the participation of targeted labour, the following definitions shall apply:

"Target area" means the Capricorn District Municipal and Mopani District Municipal areas. It must be noted that representation from the local communities within Lepelle-Nkumpi, Polokwane and Greater Tzaneen Local Municipalities is required. These local municipalities will be impacted directly by the project.

"Targeted enterprises" means any sole trader, partnership or legal entity that acts as a supplier, manufacturer, service provider or sub-contractor, and which has its base of operations in the target area.

"Targeted labour" means low and semi-skilled individuals, whose wages (excluding any benefits) do not exceed the threshold value, who reside in the target area, that are employed by the Contractor, or any of his/her sub-contractors, in the performance of the contract.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

“Threshold value” is Rate per day which will be determined by LNW will be adjusted from time to time (excluding any benefits). The threshold value is not to be confused with any industry sector minimum wage determined in accordance with the Basic Conditions of Employment Act, 75 of 1977.

“Value of the contract” means the Works Project contract sum (accepted contract amount) less provisional sums, contingencies and VAT.

C3.5.11.3 Achieving the Targeted Labour and Enterprise Contract Participation

The targeted labour contract participation shall be calculated by converting the total monetary value of wages paid to targeted labour (including that of sub-contractors).

The targeted enterprise contract participation shall be calculated by converting the total monetary value (exclusive of VAT) of the agreements between the Contractor, or Contractor’s sub-contractors, and targeted enterprises, to a percentage of the value of the contract.

The sum of the targeted labour and enterprise contract participation monetary amounts shall be evaluated as a percentage to the Value of Contract to achieve the stated goal.

The targeted labour contract participation total value of monetary wages shall be evaluated as a percentage to the Value of Contract to achieve the stated goal.

C3.5.11.4 Targeted Labour Contract Participation

The Contractor is required to provide all skills training where necessary, so as to ensure that a minimum level of competence is achieved and maintained, such that the various activities are carried out safely and to the required standard. The cost of training shall be included in the rates for the various work activities.

The Contractor will have to carry out some of the work that would normally have been undertaken using mechanised construction methods, by using labour intensive construction methods instead. It is left to the discretion of the Contractor to identify suitable work activities for the intensification of labour.

Where targeted labour is to be drawn from specific local communities (defined in terms of the target area), such labour shall be identified using the relevant Sub-Council Job-Seekers Database. The Contractor shall request, via a Community Liaison Officer (if required in terms of the contract), a list of suitable candidates from the database, from which the Contractor shall make his/her final selection. The contractor shall enter into written contracts of temporary employment with all targeted labour.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Any difficulty experienced by the Contractor in identifying candidates through the Job-Seekers Database, or as regards any matter relating to the employment of targeted labour, shall be immediately referred to the Employer's Agent.

The Contractor is required to provide all informal (on-the-job) skills training so as to ensure that a minimum level of competence is achieved and maintained, such that the various activities are carried out safely and to the required standard. The cost of informal training shall be included in the rates for the various work activities.

No credits shall be accorded should the Contractor if:

- a) The contractor/sub-contractor fail to enter into written contracts with the targeted labour.
- b) Furthermore, no credits shall be accorded in respect of targeted labour employed on work in respect of provisional sums or prime cost items. Such labour shall nevertheless be recorded on the Monthly Project Labour Report which is required to be furnished by the Contractor

C3.5.11.5 Targeted Enterprise Contract Participation

It is a requirement of this contract that enterprises located within the target area, as defined, be engaged by the Contractor for the provision of supplies, services or works necessary for the performance of this contract.

Achieving the enterprise contract participation goal:

- a) By engaging one or more targeted enterprises to perform commercially useful functions in the performance of the contract.
- b) By engaging non-targeted enterprises, who in turn engage one or more targeted enterprises to perform commercially useful functions in the performance of the contract.
- c) By a combination of the above.
- d) No credits shall be accorded should the Contractor (or sub-contractors):
- e) Make direct payment to third parties in connection with the contract on behalf of targeted enterprises, when such payment is recovered by making deductions from payments due to the targeted enterprise.
- f) Fail to enter into written contractual agreements with the relevant targeted enterprises.
- g) make use of targeted enterprises that do not adhere to statutory labour practices.
- h) make use targeted enterprises engaged on work in respect of provisional sums or prime cost items.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- i) Credits claimed towards the contract participation goal shall be denied where such written contractual agreements contain any of the following:
 - i) Conditions which are more onerous than those that exist in the prime contract (this contract).
 - ii) Payment procedures based on a pay when paid system.
 - iii) Authoritarian rights given to the employing contractor, with no recourse to independent adjudication in the event of a dispute arising.
- iv) In the event that a targeted enterprise sub-contracts to another targeted enterprise, only the value of the higher level sub-contract shall be granted as credit towards achieving the specified minimum CPGE.

In addition to the form required for contract administration (the Targeted Enterprises Contract Participation Expenditure Report), the Contractor shall furnish the Employer's Agent, upon written request, with documentary evidence that the targeted enterprises have their base of operations in the target area, copies of the contractual agreements with the various targeted enterprises, as well as documentary proof of payments made to the various targeted enterprises.

C3.5.11.6 Penalties for Non-Compliance to Targeted Labour And Enterprise Contract Participation

The financial penalty to be applied for failing to meet the specified minimum combined targeted labour and enterprises contract participation goal in the performance of the contract (unless proven to be beyond the control of the Contractor), is as follows:

$$\text{Penalty} = [(C_g - C_a) + (L_g - L_a)] \times P$$

Where:

- C_g = The specified minimum combined targeted labour and enterprises contract participation goal (expressed as a percentage)
- C_a = the combined targeted labour and enterprises contract participation goal achieved (expressed as a percentage)
- L_g = The targeted labour contract participation goal achieved (expressed as a percentage)
- L_a = The specified minimum targeted labour contract participation goal achieved (expressed as a percentage)
- P = The value of the contract

C3.5.11.7 On-job / In-service Training

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Further refer to Sub-Clause C3.6.1.5 & C3.7.7, 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.6 DETAILS OF REQUIRED CONTRACTOR'S DOCUMENTS

C3.6.1 General

The Contractor's Documents shall comprise the documents:

- a) specified in the Employer's Requirements.
- b) required to satisfy all permits, permissions, licences and other regulatory approvals which are the Contractor's responsibility under *Compliance with Laws*; and
- c) described in Sub-clause PS 6.1.6 [*As-Built Records*] and Sub-clause PS 6.1.7 [*Operation and Maintenance Manuals*].

C3.6.1.1 Preparation by the Contractor

Unless otherwise stated in the Employer's Requirements, the Contractor's Documents shall be written in the language for communications defined in **English Language**.

The Contractor shall prepare all Contractor's Documents, and any other documents necessary to complete and implement the design during execution of the Works and to instruct the Contractor's Personnel. The Employer's Personnel shall have the right to inspect the preparation of all these documents (including any investigation, modelling and testing), wherever they are being prepared.

The Contractor's Documents means all technical documentation to be provided by the Contractor for acceptance by the Engineer, including drawings, calculations, manuals, specifications, instructions, schedules, quality control plans and schedules, commissioning plans and schedules, and technical details.

Each submission of Contractor's Documents shall include a Contractor's Notice stating that they are ready for the Engineer's review.

The Contractor shall sign each drawing submitted in order to indicate approval of it.

The Contractor shall take into account the approved programme when submitting the drawings for approval and shall obtain the Employer's Agent's written approval, in accordance with the said programme, before commencing the work.

C3.6.1.2 Review by Engineer

In this Sub-Clause PS 6.1.2:

- "Review Period" means the period not exceeding 14 days, or as otherwise stated in the Employer's Requirements, calculated from the date on which the Engineer receives a Contractor's Document and a Contractor's Notice.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- “Contractor’s Document” excludes any of the Contractor’s Documents which are not specified in the Employer’s Requirements or these Conditions as being required to be submitted for Review, but includes all documents on which a specified Contractor’s Document relies for completeness; and
- “Contractor’s Notice” means the Notice which shall state that the relevant Contractor’s Document is considered by the Contractor to be ready for Review under this Sub-Clause PS 6.1.2 and for use, and that it complies with the Employer’s Requirements and these Conditions, or the extent to which it does not do so.

If the Employer’s Requirements or these Conditions specify that a Contractor’s Document is to be submitted to the Engineer for Review, it shall be submitted accordingly, together with a Contractor’s Notice.

The Engineer shall, within the Review Period, give a Notice to the Contractor:

- (i) of No-objection (which may include comments concerning minor matters which will not substantially affect the Works); or
- (ii) that the Contractor’s Document fails (to the extent stated) to comply with the Employer’s Requirements and/or the Contract, with reasons.

If the Engineer gives no Notice within the Review Period, the Engineer shall be deemed to have given a Notice of No-objection to the Contractor’s Document (provided that all other Contractor’s Documents on which that Contractor’s Document relies (if any) have been given, or are deemed to have been given, a Notice of No-objection).

If the Engineer instructs that further Contractor’s Documents are reasonably required to demonstrate that the Contractor’s design complies with the Contract, the Contractor shall prepare and submit them promptly to the Engineer at the Contractor’s cost.

If the Engineer gives a Notice under sub-paragraph (b) above, the Contractor shall:

- i) revise the Contractor’s Document.
- ii) resubmit it to the Engineer for Review in accordance with this Sub-Clause PS 6.1.2, and the Review Period shall be calculated from the date that the Engineer receives it; and
- iii) not be entitled to EOT for any delay caused by any such revision and resubmission and/or by subsequent Review by the Engineer.



Contractor



Witness 1



Witness 2



Employer



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Witness 2

If the Employer incurs additional costs as a result of such resubmission and subsequent Review, the Employer shall be entitled subject to Sub-Clause under *Claims For Payment and/or EOT* to payment by the Contractor of the costs reasonably incurred.

C3.6.1.3 Construction

Except for Contractor's Documents which are Sub-clause PS 6.1.6 "*As-Built Records/Drawings/Documents and Operation and Maintenance Manuals*", for each part of the Works requiring Contractor's Documents to be submitted for Review:

- a) construction of such a part shall not commence until a Notice of No-objection is given (or is deemed to have been given) by the Engineer for all the Contractor's Documents which are relevant to its design and execution.
- b) construction of such a part shall be in accordance with these Contractor's Documents; and
- c) the Contractor may modify any design or Contractor's Documents which have previously been submitted for Review, by giving a Notice to the Engineer with reasons. If the Contractor has commenced construction of the part of the Works to which such design or Contractor's Documents are relevant:
 - (i) work on this part shall be suspended.
 - (ii) the provisions of Sub-Clause PS 6.1.2 [*Review by Engineer*] shall apply as if the Engineer had given a Notice in respect of the Contractor's Documents under subparagraph (b) of Sub-Clause PS 6.1.2 [*Review by Engineer*]; and
 - (iii) work on this part shall not resume until a Notice of No-objection is given (or is deemed to have been given) by the Engineer for the revised documents.

C3.6.1.4 Technical Standards and Regulations

The Contractor's Documents, the execution of the Works and the completed Works (including defects remedied by the Contractor) shall comply with the South African's technical standards, building, construction and environmental Laws, Laws applicable to the product being produced from the Works, and other standards specified in the Employer's Requirements, applicable to the Works, or defined by applicable Laws.

All these technical or other standards and Laws shall, in respect of the Works, and each Section and Part, be those in force when the Works or Section or Part are taken over under Clause PS 3.27 [*Employer's Taking Over*].

References in the Contract to published standards shall be understood to be references to the edition applicable on the Base Date, unless stated otherwise. If changed or new applicable standards come into force in South Africa after the Base Date, the Contractor shall promptly give a Notice to the

Contractor

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Witness 2

Employer

Witness 1

Witness 2

Engineer and (if appropriate or requested by the Engineer) submit proposals for compliance. To the extent that:

- (a) the Engineer considers that compliance is required, and such compliance requires change(s) to the execution of the Works; and
- (b) the Contractor's proposals for compliance constitute a Variation; then the Engineer shall initiate a Variation.

C3.6.1.5 Training

Further refer to Sub-Clause PS 4.11.7 & C3.7.7, The Contractor shall carry out training of employees of the Employer (and/or other personnel identified in the Employer's Requirements) in the operation and maintenance of the Works, and any other aspect of the Works, to the extent specified in the Employer's Requirements.

If the Employer's Requirements specify training which is to be carried out before taking over, the Works shall not be considered to be completed for the purposes of taking over under Sub-Clause PS 3.27.2 [*Taking Over the Works and Sections*] until this training has been completed in accordance with the Employer's Requirements.

The timing of the training shall be as stated in the Employer's Requirements (if not stated, as acceptable to the Employer). The Contractor shall provide qualified and experienced training staff, training facilities and all training

C3.6.1.6 As Built Records

The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the work as executed by the Contractor. The format, referencing system, system of electronic storage and other relevant details of the as-built records shall be as stated in the Employer's Requirements (if not stated, as acceptable to the Engineer). These records shall be kept on the Site and shall be used exclusively for the purposes of this Sub-Clause.

The Contractor shall submit to the Engineer under Sub-Clause PS6.1.2 [*Review by Engineer*]:

The Contractor shall ensure that accurate as built records are kept of all infrastructure (pumps motors, valves, electrical & instrumentation cables routes, interconnecting pipework and cable ducts) installed during the Contract. The position of rise bends, junction boxes, duct ends and all other underground

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

infrastructure shall be given by either co-ordinates or stake value and offset. Where necessary, levels shall also be given. A marked-upset of drawings shall be kept and updated by the

Contractor. This information shall be supplied to the Engineer's Representative on a regular basis.

All information in possession of the Contractor, required by the Engineer and/or the Engineer's Representative to complete the as-built/record drawings, must be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

The Contractor shall submit to the Engineer under Sub-clause PS 6.1.2 [*Review by Engineer*]:

- a) the as-built records for the Works or Section (as the case may be) before the commencement of the Tests on Completion; and
- b) updated as-built records to the extent that any work is executed by the Contractor:
 - (i) during and/or after the Tests on Completion, before the issue of any Taking-Over Certificate under Sub-Clause PS 3.27.2 [*Taking Over the Works and Sections*]; and
 - (ii) after taking over under Sub-Clause PS 3.27.2 [*Taking Over the Works and Sections*], before the issue of the Performance Certificate.

The number of copies of as-built records to be submitted by the Contractor under shall be 3off hard copies (printed paper copies) and 2 sets of soft copies save in 2off external memory drives (external hard drives) with high capacity to save all as built-records

C3.6.1.7 Operation and Maintenance Manuals

The Contractor shall prepare, and keep up-to-date, a complete set of operation and maintenance manuals for the Works (the "O&M Manuals" in these Conditions).

The format and other relevant details of the O&M Manuals shall be as stated in the Employer's Requirements and, in any case, these manuals shall:

- a) be in sufficient detail for the Employer to:
 - i. operate, maintain and adjust the Works to ensure that the performance of the Works, Section and/or Plant (as the case may be) continues to comply with the performance criteria specified in the Employer's Requirements and the Schedule of Performance Guarantees; and
 - ii. operate, maintain, dismantle, reassemble, adjust and repair the Plant; and
- b) include an inventory of spare parts required for the Employer's future operation and maintenance of the Plant. Before commencement of the Tests on Completion, the Contractor shall submit provisional O&M Manuals for the Works or Section (as the case may be) to the Engineer under Sub-Clause PS 6.1.2 [*Review by Engineer*].

If during the Tests on Completion any error or defect is found in the provisional O&M Manuals, the Contractor shall promptly rectify the error or defect at the Contractor's risk and cost.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Before the issue of any Taking-Over Certificate under Sub-Clause PS 3.27.2 [*Taking Over the Works and Sections*], the final O&M Manuals shall be submitted to the Engineer under Sub-Clause PS 6.1.2 [*Review by Engineer*].

C3.6.1.8 General Requirements for Drawings

Drawings forming part of the Contractor's Documents shall comply with the following in addition to other requirements specified elsewhere in C3: Scope of Work:

Drawings forming part of the Contractor's Documents shall comply with the following in addition to other requirements specified elsewhere in C3: Scope of Work:

- a) Three hard copies and an electronic copy of all drawings shall be provided.
- b) A register of all the Contractor's documents and their status shall be kept.
- c) Drawings shall be prepared in accordance with the latest issue of SANS 10111.
- d) Designs shall be represented by two dimensional drawings in first or third angle orthogonal projection.
- e) Drawings shall be to scale, with both the scale and the drawing being large enough to clearly show all relevant components of the plant and equipment.
- f) Mechanical General Arrangement drawings shall be to A1 size, and shall incorporate as a minimum:
 - i) One plan view and two elevation views.
 - ii) Sectional views where this is necessary for clarity.
 - iii) Details for pipework and pipe supports.
 - iv) Layout dimensions.
 - v) A descriptive drawing title
- g) Item lists shall be provided on the drawing or on a separate parts list. Item descriptions shall include the material of construction, quantity and full identification information, including, as applicable, brand name, manufacturer's reference number, model number, size, rating, source, duty, quantity, etc.
- h) Requirements for civil work and building details shall be specifically noted

C3.6.1.9 Design Error

If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's design and/or the Contractor's Documents, they and the Works shall be corrected in accordance with Sub-Clause PS 3.26.9 [*Defects and Rejection*]. If such Contractor's Documents were previously the subject of a Notice of No-objection given (or deemed to be given) by the Engineer under

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Sub-Clause PS 6.1.2 [Review by Engineer], the provisions of Sub-Clause PS 6.1.2 shall apply as if the Engineer had given a Notice in respect of the Contractor's Documents under sub-paragraph (b) of Sub-Clause PS 6.1.2[Review by Engineer]

All corrections and resubmissions under this Sub-Clause shall be at the Contractor's risk and cost.

C3.6.2 Contractor's Documents in Respect of Mechanical and Electrical Works – Pump Stations and Water Treatment Works

C3.6.2.1 Introduction

The Contractor's Documents which shall be submitted to the Engineer for review and acceptance in respect of the Mechanical and Electrical Works – Pump Station are listed in the following table: which list does not limit the Contractor's obligations in terms of the Contract.

C3.6.2.2 General Arrangement Drawings

General Arrangement Drawings of the proposed designs. The drawings shall include layout details of pipework and pipe supports, cooling water pumps & piping and metal work showing how the equipment is to be incorporated into the structures designed by the Engineer. The General Arrangement drawings shall show the Contractor's equipment super-imposed on drawings provided by the Employer.

C3.6.2.3 Operation and Control

- a) A written description of the control system. This shall include at least as much detail as appears in the specification.
- b) MFD or PFD (mechanical flow diagram or process flow diagram).
- c) Motor and instrumentation list.
- d) Functional Design Specification with contents as per PS 9.
- e) Control panel layouts.
- f) Piping and Instrumentation Diagrams (PID) indicating all items of equipment, instruments, pipe materials and diameters. All equipment and instruments shall be tagged in accordance with a system to be approved by the Engineer, and shall be supported by referenced detailed item lists showing brand name, manufacturer's reference number, model number, size, rating, source, duty, quantity etc. All pipework (including for chemical dosing) shall be labelled with the pipe material and class. The Contractor shall base his PID on the PID provided by the Engineer, updating and expanding upon this accordingly.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.6.2.4 **Equipment**

- a) Equipment list; including every item of electronic, electrical and mechanical equipment (e.g. pump, motor, switchgear, cabling, PLC, HMI, flow meter) to be provided on the Contract shall be listed. The equipment make, model, duty, application and quantity shall be listed.
- b) Equipment certified drawings.
- c) Data sheets (brochures, manufacturer's pamphlets, catalogues) for equipment giving performance, sizing, physical and general technical data for all equipment.
- d) All equipment design and sizing calculations.
- e) All equipment inspection and testing reports.
- f) All equipment design drawings.

C3.6.2.5 **Corrosion Protection**

- a) Technical data sheets for all coatings proposed.
- b) Blast material.
- c) Pickling and passivating products.

C3.6.2.6 **MV Installation**

- a) Updated MV single line diagrams
- b) General layout drawings of all MV equipment
- c) The internal construction drawings of the MV equipment
- d) Complete wiring and protection diagrams of the MV equipment
- e) MV protection settings by specialist
- f) Detailed datasheets of all components of MV equipment, supplier detail, etc.
- g) Type tests of MV equipment (switchgear and transformers)
- h) Routine test report (Transformers)
- i) Updated earthing arrangement diagram
- j) FAT test report of switchgear
- k) Quality control procedures for MV Installation
- l) MV Variable Frequency/Speed Drives detailed datasheets of all components and type test certificates, quality control procedures, etc.

C3.6.2.7 **MV Motors**

- a) Type Test reports
- b) Routine Tests Reports
- c) Quality control procedures for the MV motors
- d) Motor starting study report (to confirm start-up voltage changes)

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- e) FAT test report of motor

C3.6.2.8 **LV Switchgear and Control Gear Assemblies**

- a) Updated single line diagrams
- b) Updated General arrangement drawings (including door arrangement and internal component layout)
- c) Wiring Schematics
- d) Components List
- e) LV assemblies type test certificates (as applicable)
- f) Factory acceptance test report
- g) Protection settings
- h) LV Switchgear room layout requirements
- i) Field control panels drawings
- j) Quality control procedures for LV assemblies

C3.6.2.9 **MV and LV Cable Routes and Supports**

- a) Cable route layout and cable support systems (indoor & outdoor) layout drawings
- b) Civil interface drawings
- c) Cable block diagrams and cable schedules
- d) Cable Test reports
- e) Quality control procedures for cables and cable supports

C3.6.2.10 **Earthing and Lightning Protection**

- a) Earthing survey report and design
- b) Earth resistivity test results after installation

C3.6.2.11 **Actuators**

- a) Actuator list (including failsafe positions)
- b) Quality control procedures for actuators and junction boxes

C3.6.2.12 **Control System**

- a) Control system architecture drawings
- b) Control Desk General Arrangement Drawings
- c) Master PLC Panel General Arrangement Drawings
- d) SCADA Rack General Arrangement Drawings
- e) PLC/Substation RTU panel schematic drawings
- f) PLC/Substation RTU loop drawings

Contractor

Witness 1

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Employer

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- g) Control system component list
- h) Control system IO list
- i) Control System equipment data sheets
- j) Control system architecture drawings
- k) HMI mimics
- l) SCADA mimics
- m) SCADA tag lists
- n) SCADA report design
- o) Factory acceptance test (hardware) and software simulation test reports
- p) Quality control procedures for control system

C3.6.2.13 Instrumentation

- a) Instrumentation list
- b) Hook-up drawings
- c) Cable schedule for power, data, control and instrumentation cables.
- d) Control and instrumentation cable block diagrams
- e) Instrument location and instrument junction box location drawings
- f) Instrument cable junction boxes general arrangement drawings
- g) Instrumentation calibration certificates

C3.6.2.14 Electrical Building Services

- a) Updated single line diagrams
- b) Lighting samples for approval

C3.6.2.15 Training

Further refer to Sub-Clause C3.5.11.7, C3.6.1.5 & C3.7.7

- a) Training Schedule
- b) Operator Training Manual

C3.6.2.16 As-Built Documents

Refer to Sub-clause C3.6.1.6 [As built Records], As built versions of all drawings and documents submitted in terms of Items 1 to 8 above. The as-built documents shall be provided in both sepia hard copy and electronic format, with the latter being both in editable (“rvt”, “dxf” or “dwg” format for drawings, MS Word format for documents and MS Excel format for schedules) and PDF format



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The number of copies of as-built records to be submitted by the Contractor under shall be 3 off hard copies (printed paper copies) and 2 sets of soft copies save in 2 off external memory drives (external hard drives) with high capacity to save all as built-records

C3.6.2.17 **Operation and Maintenance Manuals**

Refer to Sub-clause PS 6.1.7 Operations and Maintenance Manuals

- a) Contents List.
- b) Two (2) sets of draft copies of the Operation and Maintenance Manual for review by Engineer
- c) Three (3) copies of the Operation and Maintenance Manual, which shall comply with the requirements of Mech 0002.

The number of copies of Operations and Maintenance Manuals to be finally submitted as final product by the Contractor under shall be 3off hard copies (printed paper copies) and 2 sets of soft copies save in 2 off external memory drives (external hard drives) with high capacity to save all as built-records

In accordance with Clause 5.14 of the General Conditions of Contract, the Contractor shall not be entitled to receive a Certificate of Practical Completion until the O&M Manual has been accepted.

C3.6.2.18 **Tests on Completion**

- a) Plan containing the commissioning activities that will take place, including a proposed programme for these activities.
- b) Report containing detailed schedules and documentation to record all pre-commissioning tests undertaken and the results of these, demonstrating that the Works have passed the pre-commissioning tests.
- c) Report containing detailed schedules and documentation to record all commissioning tests undertaken and the results of these, demonstrating that the Works have passed the commissioning tests. The report shall include the SCADA system commissioning procedure and schedule of alarm messages, which shall additionally inserted in the Operation and Maintenance Manual.

C3.6.2.19 **Other**

- a) Pump plinth design for pumps including the forces exerted on the pump plinths.
- b) Pipe supports for the pump including the calculations for supporting the weight of valve and for restraining thrust forces resulting from pipe reducers, check valves and bends.
- c) Drawings indicating the loads exerted by all lifting equipment on structures.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- d) Design drawings of lifting equipment which indicate the vertical and horizontal limits of the hook bowl.
- e) All pump design calculations for selection, including performance curves with head, power and NPSHR
- f) Baseplate designs
- g) Design of proposed signage
- h) HAZOP study report
- i) Quality Assurance Plan covering the design of the Works
- j) Quality Control Procedures (QCP's) for all items to be fabricated and coated, showing hold points for inspection by the Engineer and the Independent Inspectorate
- k) Contractor's Health and Safety Plan

C3.6.2.20 Pump Station Point Cloud 3d Model

As part of the O&M manuals, the Contractor shall produce a visual 3D model of the completed pump station that shows the entire civil, mechanical and electrical layouts. The electronic data collection shall be done by the use of either the LIDAR or infrared (Photometry) technologies. The electronic data shall be processed to form a single comprehensive visual 3D model of the complete pump station. The 3D model shall be annotated with the P&ID information and labels.

The model shall be presented to the Employer for his acceptance. The Contractor shall allow for at least two iterations. The completed interactive 3D model shall be loaded onto the SCADA computer and easily executable, in order to do a virtual walk through inside the pump station for training, operation and maintenance measures

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.7 DETAILS OF TESTS ON COMPLETION OF MECHANICAL AND ELECTRICAL WORKS

C3.7.1 Preparation

- The Contractor shall have completed and obtained acceptance for the following from the Engineer prior to commissioning:
- All installation work, including repair to coatings and testing of all anchor fasteners.
- Manual.
- Cleaning of area.

Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start with safety. The Contractor shall provide initial fill requirements, such as lubricating oil.

C3.7.2 Starting Up

The Contractor shall arrange for the Engineer to be present at initial start-up and also for electrical and control instrumentation subcontractors to be present.

The Contractor shall start up and test each section of the Works. These tests shall be carried out to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Engineer. All necessary modifications and rectifications shall be carried out during this period.

Set-points for equipment and process parameters which are required for the operation of control systems shall be confirmed and recorded

C3.7.3 Factory And Site Test

All required factory testing and site testing are to be witnessed by the Engineer and all inspections are to be done by the Engineer. The Contractor shall make all arrangements and pay all necessary costs for the Engineer's transport, sustenance, accommodation, etc.

A written description of the testing procedure shall be forwarded to the Engineer for approval at least one week before any test.

All instrumentation and equipment shall be suitably calibrated, and calibration certificates shall be included with the test report.

The Contractor shall programme and plan the test procedure with respect to the limitations imposed by foreseeable functional and operational conditions. Where such restrictions exist, e.g. limited

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

storage volume for pumping; the Contractor shall propose and execute test procedures which optimize the technical value of the test. Planning shall be done in conjunction with the Engineer.

Site testing, where feasible, shall be done during office hours and shall be scheduled to fit in with normal operations.

C3.7.4 Testing of Control System

Testing of the control system shall be done in accordance with the SPE-II-01.

The Contractor shall submit a schedule of all control functions to be checked on Site. This shall be submitted to the Engineer before commissioning.

During commissioning of a new installation, each control system alarm and interlock shall be tested, and the resulting alarm messages shall be modified by the Contractor to be acceptable to the Engineer. A schedule of alarm messages and their full explanations shall be inserted in the Manual.

C3.7.5 Performance Acceptance

The Contractor shall demonstrate to the Engineer that the Works operates as specified by operating the plant using the specified control system over a period of at least seven consecutive days.

In addition to ensuring that the complete new installation performs successfully, the Contractor shall carry out the following performance acceptance tests in the presence of the Engineer.

The Contractor shall arrange for the Engineer to be present at initial start-up and also for electrical and control instrumentation sub-contractors to be present.

The Contractor shall start up and test each section of the Works. These tests shall be carried out to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Engineer. All necessary modifications and rectifications shall be carried out during this period.

Set-points for equipment and process parameters which are required for the operation of control systems shall be confirmed and recorded.

Performance shall not be considered to be satisfactory and acceptable until the following conditions have been confirmed by the tests and the test results have been provided in report form to the Engineer:

- a) The functionality of the system is achieved.
- b) The capacity of the pumps to ensure that they achieve the duty point specified. In the cases where no flow meter is provided the test will be carried out by a pump down test. If a flow meter is provided the flow will be measured directly from the meter.
- c) The crawl beam and hoist is functional



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.7.6 Commissioning

C3.7.6 .1 General

When all tests have been completed to the approval of the Engineer, the Works shall be commissioned.

Unless the Engineer states otherwise, all of the Works, including control functions and control systems shall be commissioned together and the process performance requirements shall be achieved during normal operation.

C3.7.6 .2 Report

A comprehensive commissioning test report, including the SCADA system commissioning procedure and schedule of alarm messages, shall be submitted by the Contractor to complete the commissioning process.

A copy shall be inserted in the Manual.

C3.7.7 Training

Further refer to Sub-Clause C3.5.11.7 & C3.6.1.5 [Training]

C3.7.7.1 Report

During the Trial Operation Period, the Employer's site staff will assist the Contractor in operating the plant and the Contractor shall train these staff in the operation of the plant and shall train the Employer's maintenance staff on the maintenance requirements and procedures

C3.7.7.2 Operational and Maintenance Tuition

The Contractor shall provide the following tuition to 15 operational staff members and 15 maintenance staff members, repeated over two sessions (as applicable to the Contract):

- a) Start up, shut down and operating instruction for all operational modes for the Works shall be provided. This shall be comprehensive and shall include actions to be taken in the case of all alarm conditions and basic fault finding.
- b) A layout drawing of the installation, a process flow diagram, and a P&ID shall be provided for each Operator.
- c) A printed copy of the Training Manual (as specified in Mech 0002) which forms part of the Installation, Operation and Maintenance Manual. Three additional copies shall be provided to the Engineer for use during the commissioning process.

Training shall include transportation of Employer's personnel and Engineer's personnel to the facilities of OEM's where training can be conducted conductively. This training might include international traveling.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.7.7.3 Certificates and Testing

Each trainee shall be provided with certification for each training session. Certificates shall indicate the Contractor's name and shall be signed by the trainer.

The Contractor shall conduct a test of the operational staff during commissioning of the plant. The test shall not be longer than 15 minutes and the test paper shall be submitted to the Engineer for acceptance. Multiple choice questions based on the information in the Training Manual will be acceptable. Test papers need not be marked but shall be forwarded to the Employer for assessment.

C3.7.8 Trial Operation Period

Once the Works has been commissioned to the approval of the Engineer, the Trial Operation Period shall start and shall consist of a continuous period of operation free from trouble. This period shall be four weeks.

The Contractor shall be available on a full time basis during this period to assist the Engineer in conducting process and hydraulic verification tests.

During the first half of the Trial Operation Period, operate the entire Works in accordance with the production requirements of the Employer (i.e. the Works is to be operated by the Contractor's Commissioning Engineers). During this time, the Contractor's personnel shall train the Employer's staff in all aspects of the operation and maintenance of the Works, making allowance for repetition to the various shift workers. The training shall include formal lectures, with the provision of lecture notes to the staff, and practical demonstration to the staff of all operation and routine maintenance actions.

During the second half of the Trial Operation Period, oversee and supervise the operation of the Works by the Employer; the Contractor's Commissioning Engineers shall be on Site for at least 8 hours a day for this purpose. During this time the Contractor's personnel shall provide on- the-job training to the Employer's operation and maintenance staff, so as to ensure that they are well-trained for the operating and maintaining of the Works.

The Contractor shall monitor and maintain the Works, and correct any defects. The Contractor shall submit to the Engineer fortnightly reports detailing the equipment failures, plant performance and problems, training logs, and shall provide an evaluation of the performance of the Employer's operators, and (ii) report on the completion of the trial operation.

Before the end of the Trial Operation Period, the Contractor shall supply two copies of "as built" versions of all Drawings provided by the Contractor and accepted by the Engineer. These drawings shall incorporate all changes found to be necessary during manufacture, assembly, installation and testing. Where applicable, the Contractor shall also provide the drawings electronically.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Practical Completion certificate will not be issued until these "as built" drawings have been provided.

The Works will not be considered complete for the purposes of Practical Completion in terms of the General Conditions of Contract, until the trial operation period and any extension thereof has been successfully completed to the satisfaction of the Engineer.

C3.7.9 Inspection Before Practical Completion

At the end of the Trial Operation Period, an inspection shall be done by the Contractor and the Engineer for the purpose of Practical Completion.

C3.7.10 Defects Liability

The Contractor's responsibilities during the Defects Notification Period are specified in Clause 7.8 of the General Conditions of Contract. This clause is in addition to the requirements of the General Conditions of Contract.

The Contractor shall at his own cost maintain the works in good order and repair for a Defects Notification Period initially of 12 months reckoned from the date of the Practical Completion and shall replace any work, parts, plant or equipment which in the opinion of the Engineer have become defective, damaged or incapable of their normal operation, due to faulty design, workmanship or material, or incorrect application or installation, during such 12 month period or during extension of the Defects Notification Period.

If any such replacements are required, the Defects Notification Period on the rectified work, parts, plant or equipment shall be extended until a period of not less than six months trouble-free operation has elapsed since the last replacement or repair.

During the Defects Notification Period the Employer's staff will carry out the normal operational duties and routine maintenance such as oiling and greasing provided these are clearly indicated in the Manual to be provided in terms of the Contract.

The fact that the Works or any portion thereof are made use of by the Employer for their designed purpose during the Defects Notification Period will in no way relieve the Contractor of any obligation.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall ensure that experienced technicians are immediately available throughout the Defects Notification Period to expeditiously deal with any faults that may develop in the operation of the Works.

If any fault shall appear or damage to any portion of the works shall occur during the Defects Notification Period, the Engineer will inform the Contractor thereof stating the nature of the fault or damage.

The Contractor shall forthwith investigate aforesaid fault or damage and report in writing to the Engineer as to its cause and extent. The Contractor shall provide details of the proposed course of corrective action within one week after having been informed of the occurrence of the fault or damage and shall repair and restore the Works to normal operation within a reasonable period which is acceptable to the Engineer.

C3.7.11 Routine Maintenance

The Contractor shall be responsible for routine maintenance of the mechanical, electrical and electronic works in the pump station during the Defects Liability Period, over and above the responsibilities of the Contractor as part of the Defects Liability Period.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.8 DETAILS OF OLIFANTSPOORT PS 1, 2, & 3 MECHANICAL AND ELECTRICAL WORKS

Preamble

The Mechanical and Electrical Works for the Olifantspoort Pump Station 1, 2 & 3 shall comply with this clause. This clause does not apply to the remainder of the Works.

C3.8.1 Scope

C3.8.1.1 General

The proposed layout and configuration of the “PS9” part of the Works are indicated on the drawings.

Drawings of the process flow diagram, P&ID and the preliminary electrical single line diagrams are also included.

The technical requirements of the project specifications are supplemented by the requirements of the standard specifications. The priority of the technical specifications is as follows:

Project Specifications (Mechanical).

Project Specifications (Electrical).

Project Specifications (Electronic).

Standard Specifications

C3.8.1.2 Scope

C3.8.1.2.1 Scope – Olifantspoort Water Scheme Pump Stations

The main items to be provided by the Contractor for the Mechanical and Electrical Works - Pump Stations are as follows:

- 1) Rehabilitation of gravel road to Olifantspoort Pump Station 1, 2 & 3
- 2) Conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir.
- 3) Multistage centrifugal pumps with motors, base- frame and coupling
- 4) Suction side isolating eccentric axis butterfly Valves on each pump leg.
- 5) Discharge nozzle type non-return valves on each pump leg.
- 6) Discharge side isolating triple eccentric butterfly valves on each pump leg.
- 7) Pipework, including flange adaptors.
- 8) Corrosion protection of pipework.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- 9) Pipework supports.
- 10) Lifting equipment
- 11) Access ladders
- 12) 6.6KV, 800Amp switchboard (incl. motor starters).
- 13) 5MVA 33/6.6kV ONAN Dyn11 transformers.
- 14) Variable Speed Drives for each motor
- 15) Surge protection for each motor.
- 16) 400V Main Switchboard and MCC panels including PLC panels
- 17) MV cables, LV cables and cable support systems.
- 18) Bonding and earthing.
- 19) Lightning protection
- 20) Certificates of compliance.
- 21) PLCs, HMIs and programming.
- 22) SCADA station at Pump Station1,2 & 3
- 23) Telemetry system
- 24) Field Instrumentation.
- 25) Control and instrumentation cables including data communications cables and associated peripherals.
- 26) Earthing and surge protection for power, instrumentation and control components.
- 27) Electrical building services
- 28) Functional Design Specification.
- 29) Operating and Maintenance Manual.
- 30) Spares.
- 31) Signage
- 32) Labelling
- 33) Inspections.
- 34) Testing.
- 35) Commissioning.
- 36) Trial Operation Period.
- 37) Training.
- 38) Rectification during Defects Notification Period.
- 39) Maintenance during Defects Notification Period.
- 40) Inspection and report during Defects Notification Period



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.8.1.3 Detailed Mechanical Works Technical Scope

C3.8.1.3.1 Olifantspoort Pump Station 1

The detailed mechanical technical scope under this pump station which includes working on an operational pumpstation (which must remain operational during construction) entails:

- Conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir.
- Development of workshop drawings for approval by the employer
- Removal of all existing high lift pumps
- Removal of all existing valves inside the pump station
- Removal of some existing pipe specials and modification of some pipe specials to suit the new the installation
- Cutting of flange on DN450 pipe and making it plain ended to be suitable for a flanged adaptor.
- Supply, Installation and testing – DN450 PN40 Flanged Knife Gate Valve (Pump suction side) including bolts, nuts, gaskets and associated pipe fittings
- Supply and installation of a new flanged adaptor, DN 450, PN40. Including Bolts and Gaskets
- Supply and installation of a new carbon steel reducer changes to DN450 PN40 / DN350 PN40
- Supply and installation of a new DN350 PN40 Dismantling Joint to be incorporated on the DN350 suction nozzle for the pump
- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 330m pumping through the proposed duplicate 1 500mm diameter main. (3 Duty and 2 Standby)
 - Also Each Multistage Pump must be able to deliver at a reduced rate of 840m³/h against the Total Dynamic Head of 368m pumping through the existing 800mm diameter main. (3 Duty and 2 Standby). The reduction of flow will be achieved via VFDs/VSDs
 - Level of Pump Axis = 744.92 mASL
 - Lowest Suction Sump Level = 1023.70 mASL
 - Size of Suction Main = 790mm Outside Diameter CML (750mm Internal Diameter)
 - Length of Suction Main = 6320m
 - Each Pump shall have a minimum efficiency of 80%



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty
- Supply, Installation and testing of 5 off new DN 350, PN 64 Nozzle check Non-return valves. Including Bolts and Gaskets
- Supply and installation of 5 off new DN300 PN 64 Dismantling Joint to be incorporated on the DN300 delivery nozzle for the pump
- Supply and installation of 5 off new DN 350, PN 64 Flanged adaptors. Including Bolts and Gaskets
- Supply and installation 5 off Carbon Steel Reducers changes to DN300 PN 64 / DN350 PN 64
- Supply, installation and testing of 5 off new Isolation Delivery Side DN350 PN64 Actuated Triple Eccentric Butterfly Valves.
- Supply, installation and testing of 5 off over-bypass DN80 carbon steel piping and DN80 PN40 Wedge Gate Valve for bypassing DN350 PN64 Actuated Valve.
- Supply, installation and testing of 2 off new cooling water PN16, DN150 suction wedge gate valves
- Supply, installation and testing of 1 off PN64, DN450 wedge gate valve on common manifold line joining to delivery common manifold for high lift pumps
- Supply and Installation of 1 off new PN64, DN450 Dismantling joint adaptor valve on common manifold line joining to delivery common manifold for high lift pumps
- Supply and Installation of a new 8 off new DN 450, PN 64, single weld on flanges common manifold line joining to delivery common manifold for high lift pumps
- Supply, Installation and testing of 1 off new DN 450, PN 64 Nozzle check Non-return valves. Including Bolts and Gaskets for common manifold line joining to delivery common manifold for high lift pumps
- Supply and installation 1 off Carbon Steel Flanged Reducer changes to DN450 PN64 / DN500 PN64 for common manifold line joining to delivery common manifold for high lift pumps.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Supply and installation 1 off Carbon Steel Flanged Reducer changes to DN500 PN64 / DN550 PN64 for delivery common manifold for high lift pumps joining to Specon Reservoirs rising main.
- Supply and Installation of a new 1off new DN 550, PN 64, single weld on flange for delivery common manifold for high lift pumps joining to Specon Reservoirs rising main.
- Supply and installation of 1 off new DN 500, PN64 Flanged adaptors. Including Bolts and Gaskets for main flow meter on delivery common manifold for high lift pumps joining to Specon Reservoirs rising main.
- Cutting of flanges on DN500 pipe and making it plain ended to be suitable for re-welding of DN500, PN64 flanges on delivery common manifold for high lift pumps joining to Specon Reservoirs rising main
- Supply and Installation of a new 8 off new DN500, PN64, single weld on flange for delivery common manifold for high lift pumps joining to Specon Reservoirs rising main.
- Supply, installation, testing and commissioning of 2 off new cooling water pumps - 5,5kW Centrifugal pumps coupled with motors including couplings and safety guards. Pump shall be able to operate within maximum head of 20m at flow rate of 15 litres/min
- Supply and installation of new cooling water carbon steel pipes to the pumps and motors, cooling water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) on the 5 pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN150 on suction side and Carbon Steel Schedule 80 pipes PN25, DN100 on delivery side.
- Supply and installation of 10 off new actuated motor cooling water valves - DN50 suction and delivery solenoid valves
- Supply, installation and testing of 2 off new cooling water PN25 DN100 wafer type non-return valve
- Supply, installation and testing of 2off new cooling water PN25 DN100 actuated delivery gate valve
- Supply, testing and installation of 2 new off service water PN16, DN200 suction wedge gate valves
- Supply, installation and commissioning of 2 off service water pumps – 32kW Centrifugal pumps (Flow Rate - 253 m³ per hour @ head = 29,22m) coupled with motors including Couplings, Safety Guards, Baseplates and anchor fasteners
- Supply and installation of 2 off new service water PN25, DN200 Wafer Type Non-Return valves



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Supply and installation of 2 off new service water PN25, DN200 actuated delivery wedge gate valves
- Supply and installation of new service water carbon steel pipes to the pumps, service water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) for 2off service pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN200 on suction side and Carbon Steel Schedule 80 pipes PN25, DN200 on delivery side.
- Supply and Installation of 3 off new high lift pump station scouring valves, DN 150, PN40 Wedge gate valves, Including Bolts and Gaskets
- Supply and Installation of 3 off new high lift pump station scouring valves, DN 150, PN40 Flanged adaptors
- Supply and installation of 1 off new DN 150, PN40 Wedge gate valve - High-Lift Pump station NS7 isolating valve
- Supply and installation of 1 off new DN 150, PN 40 Flanged adaptor-High-Lift Pump station NS7 isolating valve
- Supply and Installation of 1 off new DN 150, PN 40 Slip-on flange to be welded on pipe - High-Lift Pump station NS7 isolating valve
- Supply and install new 1 off DN 150 to DN 50 Tee piece pipe PN40- High-Lift Pump station NS7 isolating valve
- Supply and installation of 1 off new PN40 DN 50 gate valve, Including Bolts and Gaskets- High-Lift Pump station NS7 isolating valve
- Supply and Installation of a new DN 50, PN 40 Elbow pipe - High-Lift Pump station NS7 isolating valve
- Supply and installation of 1 off new DN 700, PN64 Flanged Adaptor - Critical Isolation Valve
- Supply and installation of 1 off new DN 700, PN64 One end flanged SANS 719 steel pipe, 990mm- Critical Isolation Valve
- Supply and installation of 1 off new DN 700, PN64 Triple eccentric Butterfly valve, suitable to be Actuator operated, Including Bolts and Gasket- Critical Isolation Valve
- Supply and installation 1 off new Actuator for the DN700, PN64 Butterfly valve - Critical Isolation Valve
- Clean dirt, remove paint, sand-blast, repair/weld worn sections and repaint all/entire pump station piping and flanges in accordance to pipe content colour coding SANS 1091 NATIONAL COLOUR CODING Standard

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Supply and Installation of a new 20 off new DN 350, PN 64, single weld on Flange for pump station modifications
- Supply and installation of a new 2 off DN 350, PN64, SANS 719, Steel pipe, 6m lengths to fabricate new pipe spools as /when required for delivery & suction piping systems
- Supply and installation of a new 1 off DN 350, PN25, SANS 719, Steel pipe, 3m length to fabricate new pipe spools as /when required for suction piping systems
- Supply and installation of a new 1 off DN 450, PN25, SANS 719, Steel pipe, 3m lengths to fabricate new pipe spools as /when required for suction piping systems
- Modify all pipe spools lengths (SANS 719, Steel pipe, Flange on end) with PN25 flanges on suction side , PN64 flanges on delivery sides of the pumps and pipe lengths to suit the new valves that will be supplied.
- Design, manufacture, supply and installation of new pipe supports and for valves to suit the modified suction and delivery piping system/trains
- Refurbish, repair/re-instate, test and commission existing pump station chemical (chlorine) dosing system
- Servicing, testing and certification of overhead cranes, gantries and lifting equipment for high lift pump station 1 (PS1) - 8 Ton Cross Travel Main Gantry Crane installed on the beams
- Provide equipment data packs for supplied and installed equipment
- Provide practical field training to LNW personnel involved in maintenance & operations of the high lift pump station
- Provide maintenance services to the high lift pump station for minimum of 6months duration after construction completion but before pump station hand-over.

Contractor

Witness 1

Witness 2

Employer

Witness 1

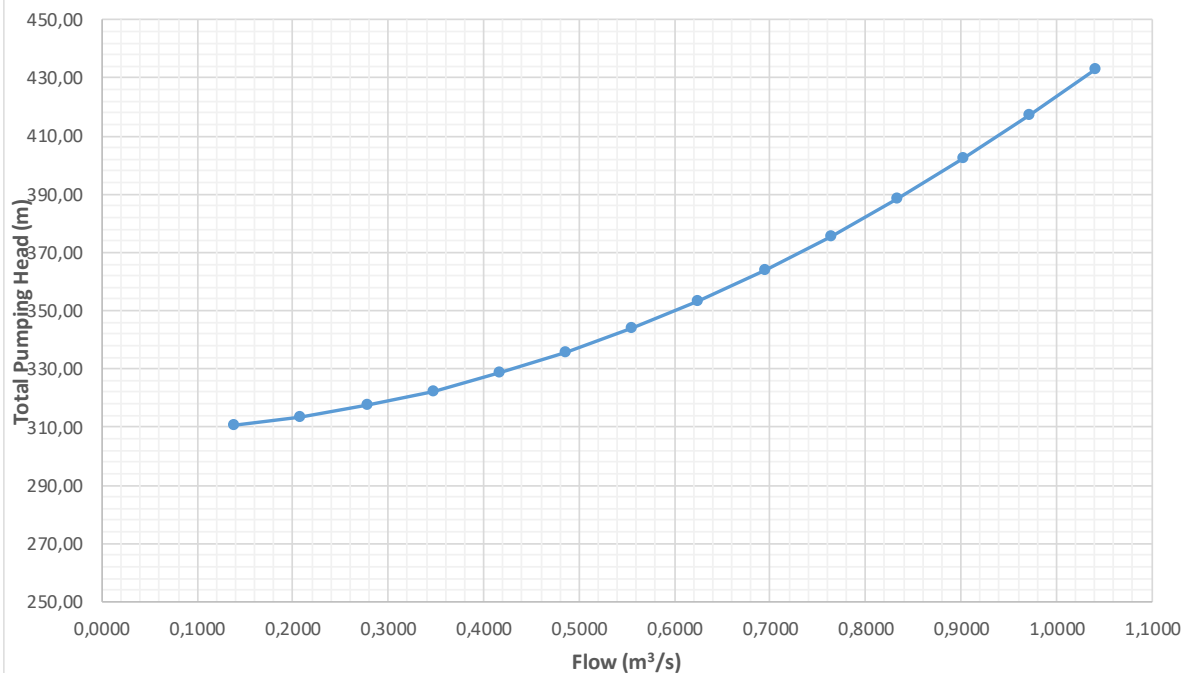
Witness 2

PS1 System Curves

Refurbished Existing 800mm Rising Main from PS1 to Specon System Table

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,1389	310,77
0,2083	313,54
0,2778	317,41
0,3472	322,40
0,4167	328,49
0,4861	335,69
0,5556	344,00
0,6250	353,42
0,6944	363,94
0,7639	375,58
0,8333	388,32
0,9028	402,17
0,9722	417,12
1,0417	433,18

Existing 800mm ND Rising Main from PS1 to Specon - System Curve



Contractor

Witness 1

Witness 2

Employer

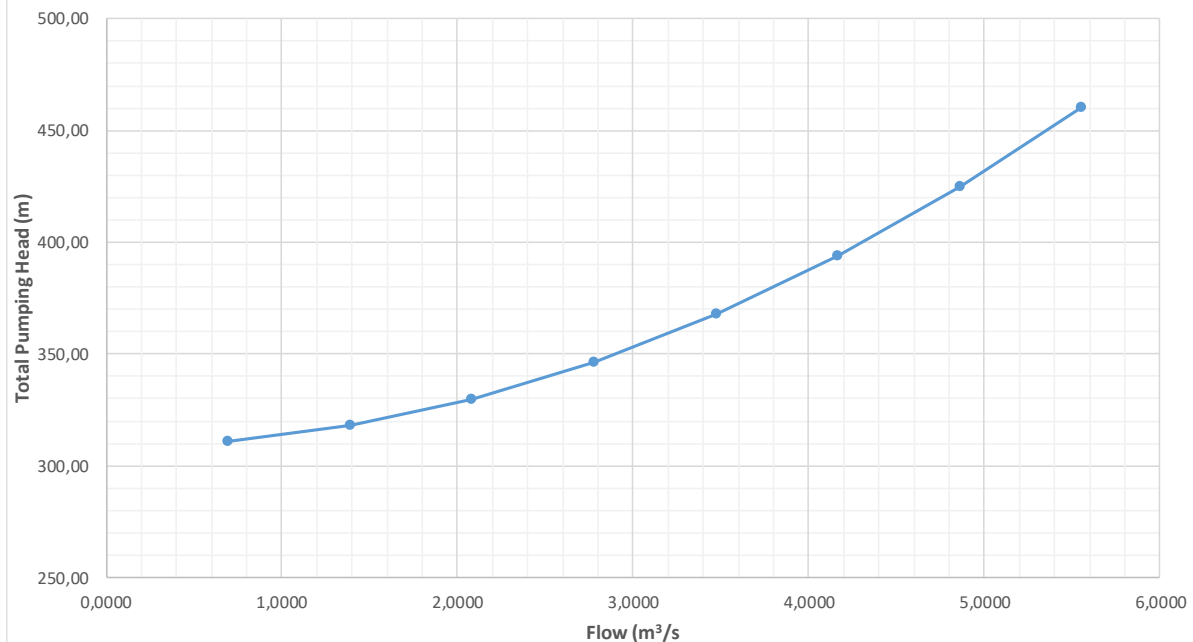
Witness 1

Witness 2

Proposed New 1 500mm NB Rising Main from PS1 to Specon System Table

Design flow - 20 hour pumping day (m ³ /s)	Total pumping head, H _t (m)
0,6944	310,92
1,3889	318,04
2,0833	329,90
2,7778	346,50
3,4722	367,84
4,1667	393,93
4,8611	424,75
5,5556	460,33

Proposed New 1 500mm NB Rising Main from PS1 to Specon System Curve



C3.8.1.3.2 Olifantspoort Pump Station 2

The detailed mechanical technical scope under this pump station which includes working on an operational pumpstation (which must remain operational during construction) entails:

- Conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir.
- Development of workshop drawings for approval by the employer

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Removal of all existing high lift pumps
- Removal of all existing valves inside the pump station
- Removal of some existing pipe specials and modification of some pipe specials to suit the new the installation
- Cutting of flange on DN450 pipe and making it plain ended to be suitable for a flanged adaptor.
- Supply, Installation and testing - DN450 PN16 Flanged Knife Gate Valve (Pump suction side) including bolts, nuts, gaskets and associated pipe fittings
- Supply and installation of a new flanged adaptor, DN 450, PN16. Including Bolts and Gaskets
- Supply and installation of a new carbon steel reducer changes to DN450 PN16 / DN350 PN16
- Supply and installation of a new DN350 PN16 Dismantling Joint to be incorporated on the DN350 suction nozzle for the pump
- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 270m. (2 Duty and 1 Standby)
 - Level of Pump Axis = 1011.51 mASL
 - Lowest Suction Sump Level = 1023.70 mASL
 - Size of Suction Main = 790mm Outside Diameter CML (750mm Internal Diameter)
 - Length of Suction Main = 6320m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Pump Testing & Certification - Hydrostatic test at 110% of it's maximum rated pressure and Performance tested to ISO 9906 1U, or at least Iso 9906 1B with no negative tolerances for Efficiency on duty
- Supply, Installation and testing of 3 off new DN 400, PN 40 Nozzle check Non-return valves. Including Bolts and Gaskets
- Supply and installation of 3 off new DN300 PN40 Dismantling Joint to be incorporated on the DN300 delivery nozzle for the pump
- Supply and installation of 3 off new DN 400, PN40 Flanged adaptors. Including Bolts and Gaskets

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Supply and installation 3 off Carbon Steel Reducers changes to DN300 PN40 / DN400 PN40
- Supply, installation and testing of 3 off new Isolation Delivery Side DN400 PN40 Actuated Triple Eccentric Butterfly Valves.
- Supply, installation and testing of 3 off over-bypass DN80 carbon steel piping and DN80 PN40 Wedge Gate Valve for bypassing DN400 PN40 Actuated Valve
- Supply and Installation of a new 6 off new DN 400, PN 40, single weld on Flange for pump station modifications
- Supply and Installation of a new 6 off new DN 500, PN 25, single weld on Flange for pump station modifications
- Supply, installation and testing of 2 off new cooling water PN16, DN150 suction wedge gate valves
- Supply, installation, testing and commissioning of 2 off new cooling water pumps - 5,5kW Centrifugal pumps coupled with motors including couplings and safety guards. Pump shall be able to operate within maximum head of 20m at flow rate of 15 litres/min
- Supply and installation of new cooling water carbon steel pipes to the pumps and motors, cooling water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) on the 5 pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN150 on suction side and Carbon Steel Schedule 80 pipes PN25, DN100 on delivery side.
- Supply and installation of 6 off new actuated motor cooling water valves - DN50 suction and delivery solenoid valves
- Supply, installation and testing of cooling water PN25 DN100 actuated delivery wedge gate valve
- Supply, installation and testing of cooling water DN100 PN 25 wafer type none return valve
- Refurbish, repair, test and commission 2 off High lift multistage centrifugal pumps - Sulzer HPL 32-17.5-30 3-stage pumps fitted with Siemens 90kW 400V squirrel cage induction motors running at 1480 rpm, DOL starting. Delivery per pump is 60 l/s at 96 metres water head. These pumps are supplying water to the high level reservoir at Lebowakgomo and the reservoir at Boomplaas
- Supply, Installation and testing 2 off DN200 PN25 Flanged Eccentric Axis Butterfly (Pump suction side) including bolts, nuts, gaskets and associated pipe fittings for rural pumps. These Flanged Butterfly Valves shall be actuated.
- Supply and installation of 2 off new flanged adaptor, DN 200, PN25. Including Bolts and Gaskets



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Supply, Installation and testing of 2 off new DN 200, PN 40 Nozzle check Non-return valves. Including Bolts and Gaskets
- Supply and installation of 2 off new DN200 PN25 Dismantling Joint to be incorporated on the DN200 delivery nozzle for the pump
- Supply and installation of 2 off new DN 200, PN40 Flanged adaptors. Including Bolts and Gaskets
- Supply and installation 2 off Carbon Steel Reducers rated at PN40 to suit the existing pump installation
- Supply, installation and testing of 2 off new Isolation Delivery Side DN200 PN40 Actuated Triple Eccentric Butterfly Valves.
- Supply, installation and testing of 2 off over-bypass DN80 carbon steel piping and DN80 PN40 Wedge Gate Valve for bypassing DN200 PN40 Actuated Valve
- Supply and installation of a new 1 off DN 400, PN40, SANS 719, Steel pipe, 6m lengths to fabricate new pipe spools as /when required for delivery piping systems
- Supply and installation of a new 1 off DN 500, PN25, SANS 719, Steel pipe, 3m length to fabricate new pipe spools as /when required for suction piping systems
- Supply and installation of a new 1 off DN 300, PN25, SANS 719, Steel pipe, 3m lengths to fabricate new pipe spools as /when required for suction piping systems
- Modify all pipe spools lengths (SANS 719, Steel pipe, Flange on end) with PN25 flanges on suction side, PN40 flanges on delivery sides of the pumps and pipe lengths to suit the new valves that will be supplied.
- Design, manufacture, supply and installation of new pipe supports and for valves to suit the modified suction and delivery piping system/trains
- Refurbish, repair/re-instate, test and commission existing pump station chemical (chlorine) dosing system
- Refurbish, repair, test and commission existing 2 off Reciprocating Compressor- 5" & 3" x 3 - 1/2"- 5.5 kW
- Refurbish, repair, test and commission existing 1 off Accumulator Pressure Vessel - 14 100 m³
- Servicing, testing and certification of overhead cranes, gantries and lifting equipment for high lift pump station 2 (PS2) – 1 off 8 Ton Main Lasch Cross Travel Gantry Crane & Steel Crawl beam and 2 off 3 Ton lifting beam
- Provide equipment data packs for supplied and installed equipment



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Provide practical field training to LNW personnel involved in maintenance & operations of the high lift pump station
- Provide maintenance services to the high lift pump station for minimum of 6 months duration after construction completion but before pump station hand-over.

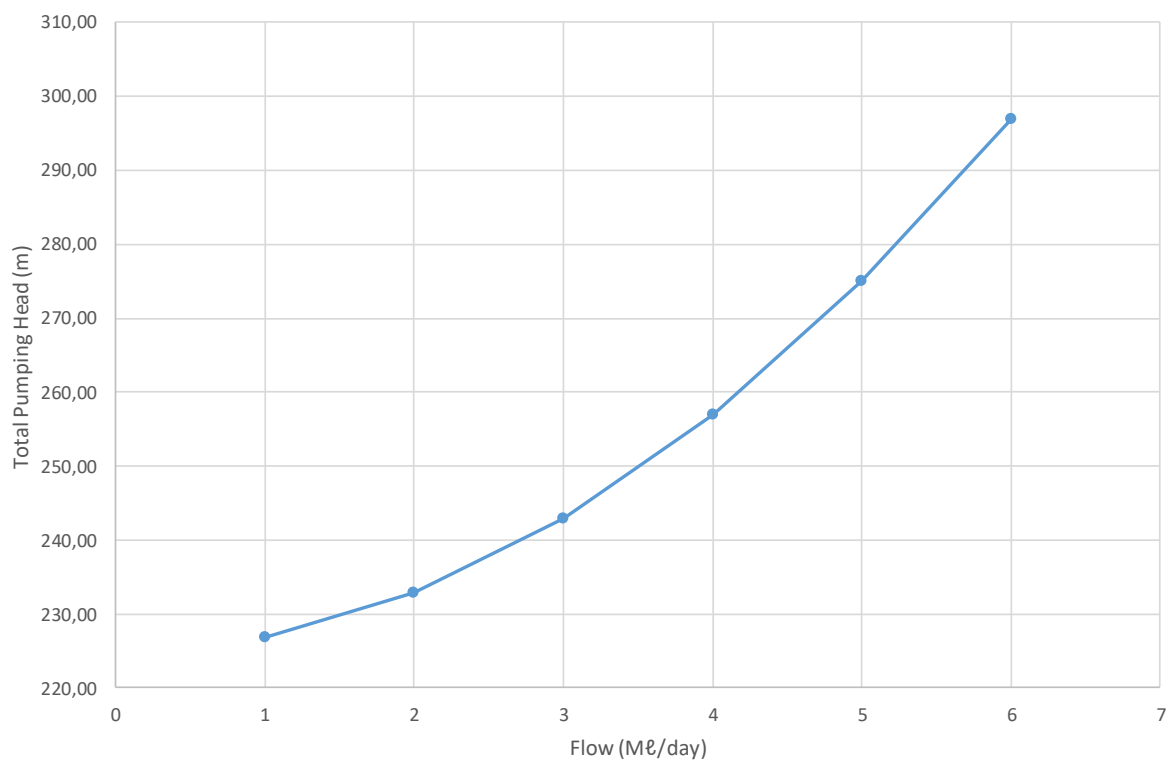
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PS2 System Curves

Existing Specon - PS2 - Witkos Pipeline - System Table

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,1389	226,91
0,2778	232,92
0,4167	242,93
0,5556	256,95
0,6944	274,97
0,8333	297,00

Existing Specon - PS2 - Witkos Pipeline - System Curve



Contractor

Witness 1

Witness 2

Employer

Witness 1

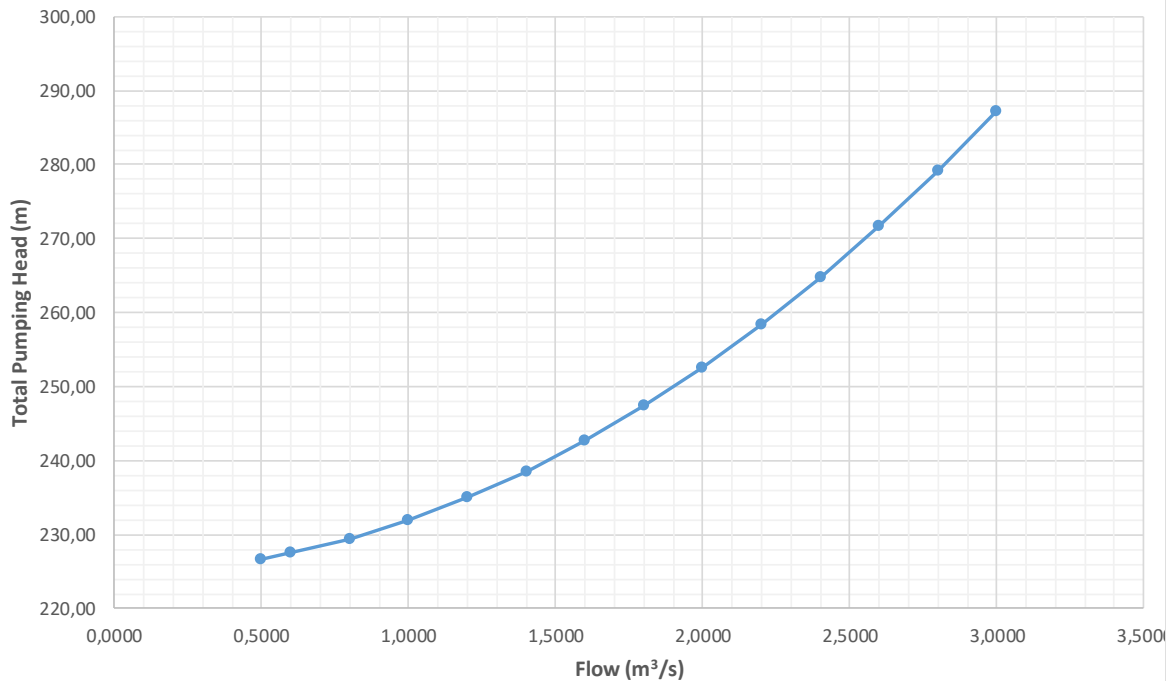
Witness 2

Specon Reservoir to PS2 & Witkos Reservoir

Pumping through a Combination of the Refurbished Existing Gravity/Rising Main & New Gravity/Rising Main

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,5000	226,74
0,6000	227,50
0,8000	229,43
1,0000	231,92
1,2000	234,95
1,4000	238,54
1,6000	242,69
1,8000	247,38
2,0000	252,63
2,2000	258,43
2,4000	264,78
2,6000	271,68
2,8000	279,14
3,0000	287,14

Specon to PS2 & Witkos - Existing Gravity/Rising Main & New
Gravity/Rising Main Combined System Curve



Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.8.1.3.3 Olifantspoort Pump Station 3

The detailed mechanical technical scope under this pump station which includes working on an operational pumpstation (which must remain operational during construction) entails:

- Conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir
- Development of workshop drawings for approval by the employer
- Removal of all existing high lift pumps
- Removal of all existing valves inside the pump station
- Removal of some existing pipe specials and modification of some pipe specials to suit the new the installation
- Cutting of flange on DN450 pipe and making it plain ended to be suitable for a flanged adaptor.
- Supply, Installation and testing - DN450 PN16 Flanged Knife Gate Valve (Pump suction side) including bolts, nuts, gaskets and associated pipe fittings
- Supply and installation of a new flanged adaptor, DN 450, PN16. Including Bolts and Gaskets
- Supply and installation of a new carbon steel reducer changes to DN450 PN16 / DN350 PN16
- Supply and installation of a new DN350 PN16 Dismantling Joint to be incorporated on the DN350 suction nozzle for the pump
- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 270m. (2 Duty and 1 Standby)
 - Level of Pump Axis = 1221.00 mASL
 - Lowest Suction Sump Level = 1227.50 mASL
 - Size of Suction Main = 740mm Outside Diameter CML (700mm Internal Diameter)
 - Length of Suction Main = 1680m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least Iso 9906 1B with no negative tolerances for Efficiency on duty



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Supply, Installation and testing of 3 off new DN 400, PN 40 Nozzle check Non-return valves. Including Bolts and Gaskets
- Supply and installation of 3 off new DN300 PN40 Dismantling Joint to be incorporated on the DN300 delivery nozzle for the pump
- Supply and installation of 3 off new DN 400, PN40 Flanged adaptors. Including Bolts and Gaskets
- Supply and installation 3 off Carbon Steel Reducers changes to DN300 PN40 / DN400 PN40
- Supply, installation and testing of 3 off new Isolation Delivery Side DN400 PN40 Actuated Triple Eccentric Butterfly Valves.
- Supply, installation and testing of 3 off over -bypass DN80 carbon steel piping and DN80 PN40 Wedge Gate Valve for bypassing DN400 PN40 Actuated Valve
- Supply and Installation of a new 6 off new DN 400, PN 40, single weld on Flange for pump station modifications
- Supply and Installation of a new 6 off new DN 500, PN 40, single weld on Flange for pump station modifications
- Supply, installation and testing of 2 off new cooling water PN25, DN100 actuated delivery wedge gate valves.
- Supply, installation and testing of 2 off cooling water PN25, DN100 wafer type non return valves
- Supply, installation, testing and commissioning of 2 off new cooling water pumps - 5,5kW Centrifugal pumps coupled with motors including couplings and safety guards. Pump shall be able to operate within maximum head of 20m at flow rate of 15 litres/min
- Supply and installation of new cooling water carbon steel pipes to the pumps and motors, cooling water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) on the 5 pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN150 on suction side and Carbon Steel Schedule 80 pipes PN25, DN100 on delivery side.
- Supply and installation of 6 off new actuated motor cooling water valves - DN50 suction and delivery solenoid valves
- Supply and installation of a new 1 off DN 400, PN40, SANS 719, Steel pipe, 6m lengths to fabricate new pipe spools as /when required for delivery piping systems
- Supply and installation of a new 1 off DN 500, PN25, SANS 719, Steel pipe, 3m length to fabricate new pipe spools as /when required for suction piping systems



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Supply and installation of a new 1 off DN 300, PN25, SANS 719, Steel pipe, 3m lengths to fabricate new pipe spools as /when required for suction piping systems
- Modify all pipe spools lengths (SANS 719, Steel pipe, Flange on end) with PN25 flanges on suction side, PN64 flanges on delivery sides of the pumps and pipe lengths to suit the new valves that will be supplied.
- Design, manufacture, supply and installation of new pipe supports and for valves to suit the modified suction and delivery piping system/trains
- Supply and installation, testing and commissioning of pump station new chemical (chlorine) dosing system
- Servicing, testing and certification of overhead cranes, gantries and lifting equipment for high lift pump station 3 (PS3) – 1 off 8 Ton Main Lasch Cross Travel Gantry Crane & Steel Crawl beam and 1 off 3 Ton lifting beam
- Provide equipment data packs for supplied and installed equipment
- Provide practical field training to LNW personnel involved in maintenance & operations of the high lift pump station.
- Provide maintenance services to the high lift pump station for minimum of 6months duration after construction completion but before pump station hand-over.

Contractor

Witness 1

Witness 2

Employer

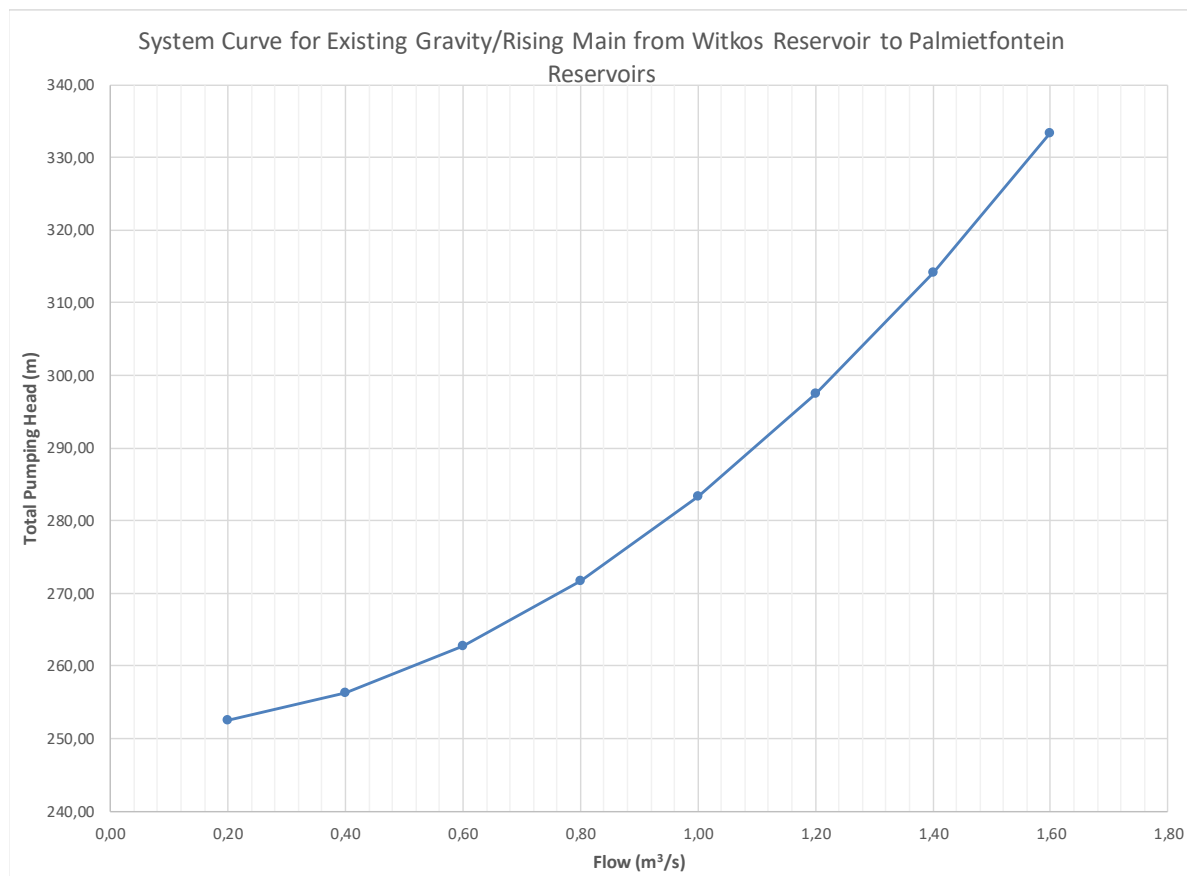
Witness 1

Witness 2

PS3 System Curves

Existing Witkos - PS3 - Palmietfontein Pipeline - System Table

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,20	252,50
0,40	256,35
0,60	262,77
0,80	271,75
1,00	283,30
1,20	297,41
1,40	314,09
1,60	333,34



Contractor

Witness 1

Witness 2

Employer

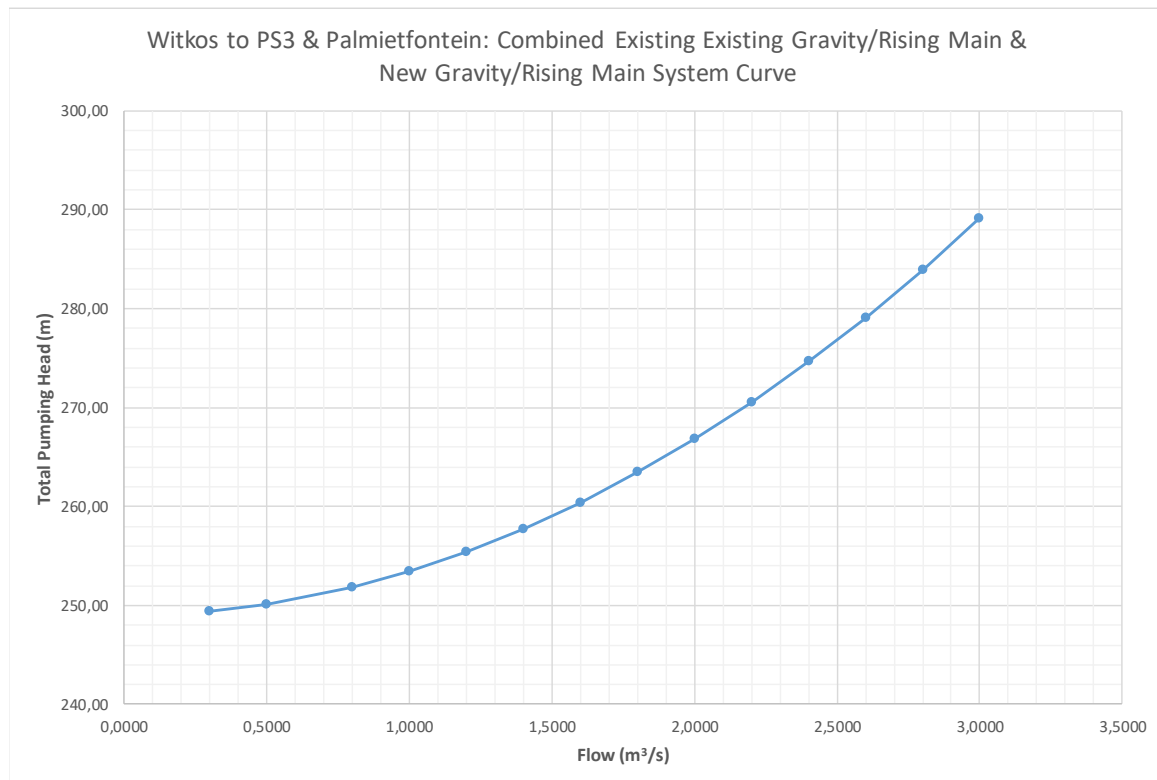
Witness 1

Witness 2

Witkos Reservoir to PS3 & Palmietfontein Reservoir Gravity / Rising Main

Pumping through a Combination of the Refurbished Existing Gravity/Rising Main & New Gravity/Rising Main

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,3000	249,42
0,5000	250,13
0,8000	251,87
1,0000	253,47
1,2000	255,43
1,4000	257,74
1,6000	260,41
1,8000	263,44
2,0000	266,82
2,2000	270,56
2,4000	274,66
2,6000	279,11
2,8000	283,91
3,0000	289,08



Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.8.1.4 Detailed Electrical, Control & Instrumentation Works Technical Scope

Olifantspoort Pump Station 1

- Replacement of 6.6 kV High Lift Pump Motors (5 off)
- Design, manufacture, supply, install and commissioning of 6.6 kV Variable Frequency Speed Drives (5 off)
- Maintenance and servicing of 6.6 kV High Lift Switchgear including relay settings, primary and secondary injection testing
- Refurbishment of 400V Main Switchboard
- Supply and installation of power cables (MV and LV) and control cables
- Upgrade of Pumps PLC systems
- Upgrade of Common Control PLC system and HMI
- Calibration of all instrumentation and metering equipment
- Automate all isolating valves (Suction and Delivery Site) by installing electrical actuators and Remote IO cards (10 off)
- Automate all cooling and service water pump and isolating valves
- Upgrade Pump Station SCADA and Telemetry System
- Earthing and lightning protection testing and repairing including issuing Certificate of compliance
- Small power and lighting refurbishment including installation of energy efficient lighting
- Replacement of High Lift Switchgear batteries and refurbishment of battery charger unit
- Supply and install 10kVA uninterruptible power supply (UPS) unit

Olifantspoort Pump Station 2

- Replacement of 6.6 kV High Lift Pump Motors (3 off)
- Design, manufacture, supply, install and commissioning of 6.6kV Variable Frequency Speed Drives (3 off)
- Maintenance and servicing of 6.6 kV High Lift Switchgear including relay settings, primary and secondary injection testing
- Refurbishment of 400V Main Switchboard
- Supply and installation of power cables (MV and LV) and control cables
- Upgrade of Pumps PLC systems
- Upgrade of Common Control PLC system and HMI
- Calibration of all instrumentation and metering equipment



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Automate all isolating valves (Suction and Delivery Site) by installing electrical actuators and Remote IO cards (6 off)
- Automate all cooling and service water pump and isolating valves
- Upgrade Pump Station SCADA and Telemetry System
- Earthing and lightning protection testing and repairing including issuing Certificate of compliance
- Small power and lighting refurbishment including installation of energy efficient lighting
- Replacement of High Lift Switchgear batteries and refurbishment of battery charger unit
- Supply and install 10kVA uninterruptible power supply (UPS) unit

Olifantspoort Pump Station 3

- Replacement of 6.6kV High Lift Pump Motors (3 off)
- Design, manufacture, supply, install and commissioning of 6.6kV Variable Frequency Speed Drives (3 off)
- Maintenance and servicing of 6.6kV High Lift Switchgear including relay settings, primary and secondary injection testing
- Refurbishment of 400V Main Switchboard
- Supply and installation of power cables (MV and LV) and control cables
- Upgrade of Pumps PLC systems
- Upgrade of Common Control PLC system and HMI
- Calibration of all instrumentation and metering equipment
- Automate all isolating valves (Suction and Delivery Site) by installing electrical actuators and Remote IO cards (6 off)
- Automate all cooling and service water pump and isolating valves
- Upgrade Pump Station SCADA and Telemetry System
- Earthing and lightning protection testing and repairing including issuing Certificate of compliance
- Small power and lighting refurbishment including installation of energy efficient lighting
- Replacement of High Lift Switchgear batteries and refurbishment of battery charger unit
- Supply and install 10kVA uninterruptible power supply (UPS) unit



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.8.1.5 Configuration, Installation & Testing

The design of the installation shall provide for the completed installation to be suitable **for testing to ISO 9906 Acceptance grade 2B** on Site during commissioning.

C3.8.1.6 Witness Testing and Factory Inspections

The Contractor shall allow for the Engineer and Engineer's representatives to travel from Johannesburg and the Employer and Employer's representatives to travel from Polokwane for all witness testing and factory inspections.

C3.8.1.7 Maintenance Services for Pump Stations

C3.8.1.7.1 Scope of Works

The scope of works includes the assistance, execution of necessary actions and insurance that equipment are maintained and kept operation to ensure the operation of the facility, falling under the contract scope of works. LNW and Contractor will enter into Service Level Agreement for maintenance of Pump Stations to ensure there are no interruptions of

C3.8.1.7.2 Works

The maintenance scope of works will typically entail the following:

- 24-hour facility monitoring to ensure that Pump Stations equipment performs its function.
- 24-hour assistance from the contractor to the service LNW.
- Routine equipment inspections & monitoring.
- Continuously collect data such as temperatures, vibrations, pressures, Amps, flow rates, etc on equipment performance, then analyse to produce performance trends
- Execute scheduled equipment lubrication and performance checks.
- Execute scheduled/periodic maintenance work as per OEM recommendations
- Attend breakdown maintenance work.
- Emergency replacement work on critical essential equipment.

C3.8.1.7.3 Requirements

Requirements during the maintenance service, entail the following:

- The contractor will at all times ensure, that LNW is assisted where ongoing refurbishment work takes place.
- The contractor will ensure minimum repair time to ensure the approved completion target date are met.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Service means any form of action, work, support, material, equipment to ensure the operation of the facility.
- The service must at all times comply with the relevant Particular Specifications, SANS and OHS Act regulations.

C3.8.2 Process and Control

PS 9.2.1 General

The Contractor is responsible for providing the control functions described below.

The detailed requirements for electronic equipment are specified elsewhere.

C3.8.2.2 PFDs and P&IDs

The P&IDs shown on drawing explains the overall system.

C3.8.2.3 Water Sources, Reservoirs and Network for Olifantspoort Scheme

To be discussed with Appointed Contractor prior to commencement of construction.

C3.8.2.4 Pump Control

C3.8.2.4.1 Modes of operation (future and emergency)

The pump stations shall have 3 modes of operation. The mode selection shall be done on the equipment's respective control panels.

a) Manual/maintenance mode

In this mode equipment shall be controlled from the switchgear panel or MCC and only the essential protection (safety interlocks) shall be active in this mode. This mode is selected by setting the local/remote switch on the equipment panel to *local*. A special key shall be required to switch to manual/maintenance mode.

b) Semi-Auto Mode

In this mode equipment are controlled by the PLC control system and all protection (safety and process interlocks) shall be active. Equipment e.g. the pumps can be started from the pumpset HMIs via the PLC control system in this mode. This mode is selected by setting the local/remote switch on the equipment panels to *remote*.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

c) Auto / SCADA Mode

This mode is similar to the previous mode, but now equipment can be controlled via the local SCADA in the control room.

C3.8.2.4.2 Pump Stations Operation

The pump station shall be automatically controlled based on water levels in the Suction and Command Reservoir. If the water level in the command reservoir is low (<75%) and the water level in the suction reservoir is sufficient (>20%) the pumps shall be started. The control system shall monitor the water levels in the reservoirs and stop the pump if the water level is above 95% (high) in the command reservoir (future) and/or below 20% (low) in the suction reservoir. The Contractor shall provide hydrostatic level meters in the Suction Reservoir and Command Reservoir and shall transmit these levels to the pump station for incorporation into the control system. The level meters shall also be used for providing alarms for low level and high level in the reservoirs. Loss of communication shall not prevent automatic operation of the pump station from continuing.

In addition to the level monitoring, a level switch shall be provided in each reservoir for low level protection in the Suction Reservoir and high level protection in the Command Reservoir.

C3.8.2.4.3 Pump Station Operation (Emergency Supply)

The pump station control as part of the emergency supply shall be similar to that of the future scheme described above except for the following:

- a) The pump station shall continue to operate as long as the water level in the Suction Reservoir is sufficient (>20%).
- b) The pump station shall stop when the water level in the Suction reservoir is insufficient (<20%).

C3.8.2.4.4 Normal Start Up

A pumpset shall start through Variable Speed Drives with the suction side isolation valve open and the actuated delivery isolation valve closed. The actuated delivery isolation valve shall start to open upon the pump receiving a start signal and shall open over a period of approximately 60 seconds (minimum of 30 seconds, to be confirmed during Commissioning).



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

A second pumpset shall also start in this manner but only once the first pump actuated delivery isolation valve is fully open.

In Pump Station 2 and 3, the two pumps with the least number of operating hours shall become the duty pumps. The pump with the least number of operating hours shall become the first duty pump.

For Pump Station 1

A third pumpset shall also start in this manner but only once the second pump actuated delivery isolation valve is fully open.

A fourth pumpset shall also start in this manner but only once the third pump actuated delivery isolation valve is fully open.

In Pump Station1, the four pumps with the least number of operating hours shall become the duty pumps. The pump with the least number of operating hours shall become the first DUTY pump and the pump with most operating hours shall be the first to be a STANDBY pump.

C3.8.3 General Mechanical Requirements

The Works shall comply with Mech 0001 for the following general requirements:

- Materials
- Castings
- Fabrication of steels
- Welding
- Installation
- Civil and building works
- Pipework supports
- Base frames
- Machine guards
- Shaft couplings
- Gearboxes
- Bearings
- Lubrication
- Gauges

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Fasteners
- Machine vibration
- Noise control
- Spares
- Signage

C3.8.4 Multi-Stage Horizontal Centrifugal Pumps

C3.8.4.1 Specification

The pumps shall be multi -stage, ring-section centrifugal units with horizontal shaft and shall comply with Mechanical Specifications. The multi-stage centrifugal pumps shall further comply with following specifications:

- Suction nozzle on drive-end, and positioned horizontal (90 right from Drive-end DE)
- Discharge nozzle on Non-Drive-End (NDE) and positioned horizontal (270° from DE)
- Bronze Impellers (or 316 Stainless Steel), casted units and balanced (cert 3.1 / 2)
- Bronze or suitable diffusers
- Rotating assembly dynamically balanced
- Pump must be hydrostatically tested at 110% it's maximum rated pressure (at least) or 120 maximum duty pressure
- Pump set Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty
- Pumps to be able to be operated through the utilization of Variable Speed Drives /Variable Frequency Drives.
- Pump Critical Speed at least 125% above maximum speed of maximum duty.
- PT100 Bearing Temperature Sensors on both Bearings (DE & NDE) with 4-20mA transducers to SCADA
- Vibration Sensors on both Bearings (DE & NDE) Signal to SCADA
- Casing Temperature Sensor PT100 with 4-20mA signal to SCADA
- i. Olifantspoort Pumps Station 1: Treated drinking water will be pumped from Olifantspoort Water Treatment Works Contact Tanks/Reservoirs/Suction Reservoirs and be pumped to Command Reservoirs at Specon reservoirs complex located in Lebowakgomo.
- ii. Olifantspoort Pump Station 2 – Water gravitates from Specon reservoirs to suction common manifold of the pump station, then water be pumped to Command Reservoirs located at Witkos Reservoirs complex.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- iii. Olifantspoort Pump Station 3 – Water gravitates from Witkos reservoirs to suction common manifold of the pump station, then water be pumped to Palmietfontein Command Reservoirs.

C3.8.4.2 Amendments, Additions and Detailed Requirements

- i. Olifantspoort Pumps Station 1- The Contractor shall provide 5 pumpsets as shown on the drawings. The Contractor shall provide all items specified for each pumpset:
- ii. Olifantspoort Pumps Station 2- The Contractor shall provide 3 pumpsets as shown on the drawings. The Contractor shall provide all items specified for each pumpset
- iii. Olifantspoort Pumps Station 3- The Contractor shall provide 3 pumpsets as shown on the drawings. The Contractor shall provide all items specified for each pumpset

The items for each pump set includes:

- a) Pump.
- b) Pump motor.
- c) Base frame and anchor fasteners.
- d) Shaft coupling.
- e) Shaft/coupling guard.

Items required for the pumpsets but also specified elsewhere are as follows:

- a) Insertion magnetic flow sensor.
- b) Pressure gauges.
- c) Pressure transmitters.
- d) Pipework.
- e) Flange adaptors.
- f) Suction isolation eccentric butterfly valves
- g) Discharge isolation Actuated Butterfly Valve gate valve
- h) Nozzle check Non-return valve
- i) Electrical and control equipment.

C3.8.4.3 Performance Requirements

Pump Station 1

- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 330m. (3 Duty and 2 Standby)



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Also Each Multistage Pump must be able to deliver at a reduced rate of 840m³/h against the Total Dynamic Head of 368m. (3 Duty and 2 Standby). The reduction of flow will be achieved via VFDs/VSDs
- Level of Pump Axis = 744.92 mASL
- Lowest Suction Sump Level = 1023.70 mASL
- Size of Suction Main = 790mm Outside Diameter CML (750mm Internal Diameter)
- Length of Suction Main = 6320m
- Each Pump shall have a minimum efficiency of 80%
- Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
- Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty

Pump Station 2

- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 270m. (2 Duty and 1 Standby)
 - Level of Pump Axis = 1011.51 mASL
 - Lowest Suction Sump Level = 1023.70 mASL
 - Size of Suction Main = 790mm Outside Diameter CML (750mm Internal Diameter)
 - Length of Suction Main = 6320m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Pump Testing & Certification - Hydrostatic test at 110% of it's maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty

Pump Station 3



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 1250m³/h against the Total Dynamic Head of 270m. (2 Duty and 1 Standby)
 - Level of Pump Axis = 1221.00 mASL
 - Lowest Suction Sump Level = 1227.50 mASL
 - Size of Suction Main = 740mm Outside Diameter CML (700mm Internal Diameter)
 - Length of Suction Main = 1680m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Each pump shall be driven by 1700kW Electric Motor (Motor specified below)
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty

C3.8.4.4 Witness Testing

These pumps will require witness testing as specified. During performance testing at the guarantee point, the guaranteed performance for differential pressure across the pump, volume flow and energy efficiency shall be confirmed within the standard's tolerances.

During pressure testing of the pump casing, the pump shall not leak. The tendered NPSHR shall be achieved or surpassed.

C3.8.5 Eccentric Axis Butterfly Valves

C3.8.5.1 Specification

Water Industry Mechanical And Electrical Specifications 8.09 - WIMES 8.09, issue 01 January 2014

Butterfly isolation valves shall comply with DWS 2510.04.

Electric actuators shall comply with DWS 2510.02.

Corrosion protection shall comply with DWS 9900 C7.

Installation work shall comply with Mech 0001.

This valve shall be Tripple Eccentric Butterfly Valve to EN 593 for neutral liquids like drinking water .



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Design standards:

- EN 593
- Face-to-face dimension according to EN 558 Table 2 Basic Series 13
- Flange drilling to EN1092, PN10/16

Test/Approvals:

- Hydraulic test according to EN 1074-1 and 2 / EN 12266
- Approved for drinking water according to WRAS

Component list:

1.Body	Ductile iron GJS-500-7 (GGG-50)	16.	Thrust bearing	Bronze
2.Shaft, drive	Stainless steel AISI 420	17.	End plate	Ductile iron GJS-500-7
3.Bearing	Bronze/PTFE composite	18.	Washers	Stainless steel A2
4.O-rings	EPDM rubber	19.	Bolts	Stainless steel A2
5.Bolt, socket head	Stainless steel A2	20.	Nut	Stainless steel A2
6.Cover	Stainless steel	21.	Seal retainer ring	Stainless steel
7.Gasket	EPDM rubber	22.	Seal ring	EPDM rubber
8.Key	Stainless steel A2	23.	Gearbox	Cast iron
9.Set screws	Stainless steel A2			
10. Disc	Ductile iron GJS-500-7			
11. End cover	Stainless steel			
12. Screw	Stainless steel A2			
13. Shaft, stub	Stainless steel AISI 420			
14. Seal ring	EPDM rubber			
15. Spacer	Bronze			

C3.8.5.2 Scope

The valves shall be installed as shown on the drawings.

The valves shall be provided with electric actuators. Actuated valves shall be provided with manual override. Actuators shall also be provided with manual start and stop functions at the valve.

The Contractor shall make all arrangements and carry all transport and accommodation costs for the Engineer and one representative of the Employer to witness the testing of the valves at the manufacturer's premises.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall make arrangements for the Engineer to inspect and witness the testing of the valves for compliance prior to payment being made. If the valves are manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for the Engineer and one representative of the Employer to inspect and witness the testing of the valves in the workshop prior to despatch to Site. If the valve is not manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for an Engineer approved inspection authority to inspect and witness the testing of the valves in the workshop prior to dispatch. The inspection shall include a full report on compliance with this specification and this report shall be submitted to the Engineer prior to dispatch of the unit from the workshop.

Test certificates shall be submitted to the Engineer for all valves.

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.

C3.8.5.3 Amendments, Additions and Detailed Requirements

C3.8.5.3.1 General (Clause 1)

The valves shall be of the triple eccentric, resilient seal type.

The valves shall be suitable for the flow, internal pressure and differential pressure conditions of the pumping system which is specified elsewhere in PS9.

These valves will be open under normal operating conditions.

They will generally be used for maintenance purposes and will not be operated on a regular basis.

The valve 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 Africa. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable. Valves which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

Valves shall seal drop tight in the required direction(s) at the PN rating of the valve.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

It shall not be possible to damage any component by over-torquing.

Motor driven gearboxes shall comply with the requirements for motor driven gearboxes in Mech 0001. Gearbox service factors shall be chosen in accordance with this specification or shall comply with the guidelines of AGMA.

Manual gearboxes shall comply with the requirements for manual gearboxes” in Mech 0001.

C3.8.5.3.2 Construction and Operational Requirements (Clause 2)

Handwheels shall be clockwise closing. A slipping clutch or equivalent mechanism shall prevent over-torque which would cause damage. Torque limiting devices which have to be replaced after activation, such as shear pins, are not acceptable.

The main seal shall be uncompressed when the valve is open. It shall be replaceable by removing the retaining ring.

The shaft shall be provided with o-ring seals. The valve shall incorporate provision for attaching limit switches for signalling valve fully open and valve fully closed.

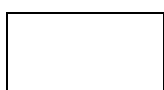
Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the disc when it is subjected to a differential pressure equal to the rated pressure difference across the disc. Handwheels shall not require a peripheral force greater than 250 Newtons (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons).

Valves shall comply with the following additional requirements:

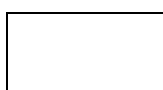
- a) Valves shall be provided with a bypass. The bypass pipework shall be flanged pipework and a flanged stainless steel ball valve shall be provided on the bypass.
- b) Valves shall have the manufacturer's name, size, working pressure and flow direction integrally cast with the valve body.
- c) Manually operated gearboxes shall be provided with a stainless steel grease nipple.

C3.8.5.3.3 Valve Material Specifications (Clause 3)

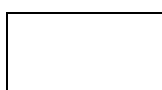
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be completely clear of ferrous stain and heat tint at commissioning.



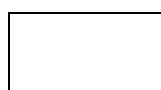
Contractor



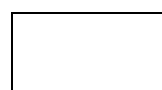
Witness 1



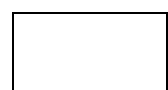
Witness 2



Employer



Witness 1



Witness 2

Carbon steel parts (wrought) are not acceptable either internally or externally. This includes high tensile items such as pins, roll pins, dowels etc.

- Electrolytically applied plating of ferrous materials is not acceptable.
- The application shall be taken into account in the corrosion protection of valves.
- Handwheels shall be of cast or forged metal (cast iron or aluminium) or shall be of stainless steel.
- All other external metal components shall be of EN Grade 1.4401 (316).
- Materials shall comply with the requirements for material in Mech 0001. Delete Sub-Clause 3.3 to 3.5.
- The valves shall be lined with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a top coat of pure aliphatic polyurethane to a minimum dry film thickness of 25 micron.
- The valves shall be coated with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a re-coatable top coat of polyurethane to a minimum dry film thickness of 40 micron.

C3.8.6 Nozzle Check Valves

PS 9.6.1 Specification

- Water Industry Mechanical And Electrical Specifications 8.09 - WIMES 8.09, issue 01 January 2014
- Nozzle check valves shall comply with Mech 7012.
- Corrosion protection shall comply with DWS 9900 C7

C3.8.6.2 Amendments, Additions and Detailed Requirements

C3.8.6.2.1 Scope of Works (Clause 2)

DN350 PN64 and DN450 PN64 rated double flanged nozzle check valve with spring closing shall be provided in the discharge manifold. The valve shall be provided with a proximity switch to indicate no flow. The valve shall be installed as per drawings.

C3.8.6.2.2 Performance Requirements

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The valves shall be suitable for the flow, internal pressure and differential pressure conditions of pumping system which is specified elsewhere in PS9.

C3.8.6.2.3 Design and Construction

The valve will close when the pump station is not operational.

The valve shall be designed for non-slam closure

C3.8.6.2.4 Materials and Coatings

The valves shall be lined with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a top coat of pure aliphatic polyurethane to a minimum dry film thickness of 25 micron.

The valves shall be coated with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a re-coatable top coat of polyurethane to a minimum dry film thickness of 40 micron.

C3.8.6.2.5 Installation

The valves shall be positioned at least 6 x DN value of the discharge manifold downstream of the ultrasonic flow meter.

Check valves shall be separated from downstream isolation valves by a distance of at least 1,5 times the pipe diameter.

C3.8.6.2.6 Testing Requirements

The Contractor shall make all arrangements and carry all transport and accommodation costs for the Engineer and one representative of the Employer to witness the testing of the valves.

Check valves shall be separated from downstream isolation valves by a distance of at least 1,5 times the pipe diameter.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.8.6.2.7 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.09 - WIMES 8.09, issue 01 January 2014

3.8.7 Pipework Supports

C3.8.7.1 Specification

Pipework supports shall comply with Mech 7024

C3.8.7.2 Amendments, Additions and Detailed Requirements

C3.8.7.2.1 Performance Requirements

The Contractor shall provide all pipe supports required to adequately secure the pipework and shall anchor these pipe supports (to suitable concrete structures) in order to satisfy the performance requirements specified.

The contractor shall provide all supports required to adequately secure the suction isolation valves, plunger valves and discharge manifold nozzle check valve.

C3.8.7.2.2 Construction and Design

The pipework supports shall be made from Grade S355JR or better (in terms of yield strength).

The Contractor shall provide all forces acting on pipework supports and valve supports to the Engineer for design of the concrete plinths.

C3.8.7.2.3 Corrosion Protection

Pipe supports shall be hot dip galvanized and shall comply with DWS 9900 C7.

C3.8.7.2.4 Inspections

The Contractor shall make arrangements and carry all transport and accommodation costs for the Engineer to inspect the pipe support fabrications before they are corrosion protected

C3.8.8 Couplings and Flange Adaptors

C3.8.8.1 Specification

Flange adaptors shall comply with Mech 7023.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.8.8.2 Amendments, Additions and Detailed Requirements

C3.8.8.2.1 Scope

The Contractor shall provide flange adaptors for misalignment and dismantling purposes

C3.8.8.2.2 Performance Requirements

The flange adaptors shall have the same pressure rating as the parent pipe.

C3.8.8.2.3 Construction and Design

The adaptor body and end ring shall not be made of castings, but shall be fabricated items

C3.8.8.2.4 Corrosion Protection

Corrosion protection shall comply with DWS 9900 C7.

Couplings and flange adaptors shall be lined and coated with fusion bonded epoxy to a minimum dry film thickness of 300 microns.

C3.8.8.2.5 Inspections

The Contractor shall make arrangements for the Engineer to inspect the couplings and flange adaptors before they are corrosion protected.

C3.8.9 COMPRESSED AIR SYSTEMS

C3.8.9.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.07 - WIMES 8.07, Issue 04, October 2012 or later

C3.8.10 MECHANICAL INSTALLATIONS

C3.8.10.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.03 - WIMES 8.03, issue 04, August 2016 or later

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.8.11 PAINTS & POLYMERIC COATINGS FOR CORROSION PROTECTION

PS 9.11.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 4.01 - WIMES 4.01, issue 04, October 2013 or later

C3.9 DETAILS OF EBENEZER WTW AND PS MECHANICAL AND ELECTRICAL WORKS

Preamble

The Mechanical and Electrical Works for the Ebenezer Water Treatment Works and High Lift Pump Station shall comply with this clause. This clause does not apply to the remainder of the Works.

C3.9.1 Scope

C3.9.1.1 General

The proposed layout and configuration of the "PS9" part of the Works are indicated on the drawings.

Drawings of the process flow diagram, P&ID and the preliminary electrical single line diagrams are also included.

The technical requirements of the project specifications are supplemented by the requirements of the standard specifications. The priority of the technical specifications is as follows:

Project Specifications (Mechanical).

Project Specifications (Electrical).

Project Specifications (Electronic).

Standard Specifications

C3.9.1.2 Scope

The main items to be provided by the Contractor for the Civils, Mechanical and Electrical Works –

A. Water Treatment Plant is as follows:

The scope entails the upgrading of the existing works to enable an increased flow throughput while maintaining acceptable water quality standards. This will entail the replacement of the lime dosing system to ensure accurate dosing and achieve pH_s (saturation pH in terms of calcium carbonate)

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quality of the final water and thereby protect downstream infrastructure; the upgrading of the polyelectrolyte dosing station; the construction of a new rapid mix / flocculation channel to improve floc development while maintaining a low polyelectrolyte dosing regimen; upgrading of the filter valves to all actuator operation; replacement of 50% of the filter sand with anthracite media requiring the raising of the filter overflow walls by 250mm. The chlorination dosing system is currently not performing as required and the change-over mechanism is not operational as required. The backwash water is discharged to a sludge dam, with the supernatant water being of a good enough quality to return to the works. A supernatant sump and pump station is to be constructed at the sludge dam and connected to the existing rising main. The instrumentation on the plant is to be upgraded to facilitate improved operator controls and measurement.

The refurbished and newly installed equipment shall comply with the latest applicable national standards and regulations.

B. High Lift Pump Station is as follows:

- 1) Minor upgrades of water treatment works and high lift pump station
- 2) Multistage centrifugal pumps with motors, base frame and coupling.
- 3) Suction side isolating double eccentric butterfly valves on each pump leg.
- 4) Discharge non-return valves on each pump leg.
- 5) Discharge side isolating triple eccentric butterfly on each pump leg.
- 6) Pipework, including flange adaptors.
- 7) Corrosion protection of pipework.
- 8) Pipework supports.
- 9) Lifting equipment.
- 10) 6.6kV Variable Frequency/Speed Drives for each new motor.
- 11) Surge protection for each motor.
- 12) 400V Main Switchboard and MCC panels including PLC panels
- 13) MV cables, LV cables and cable support systems.
- 14) Bonding and earthing.
- 15) Lightning protection
- 16) Certificates of compliance.
- 17) PLCs, HMIs and programming.
- 18) SCADA station at Water Treatment Works and High Lift Pump Station
- 19) Telemetry system
- 20) Field Instrumentation.



Contractor



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Witness 1



Witness 2

- 21) Control and instrumentation cables including data communications cables and associated peripherals.
- 22) Earthing and surge protection for power, instrumentation and control components.
- 23) Electrical building services.
- 24) Functional Design Specification.
- 25) Operating and Maintenance Manual.
- 26) Spares.
- 27) Signage.
- 28) Labelling
- 29) Inspections.
- 30) Testing.
- 31) Commissioning.
- 32) Trial Operation Period.
- 33) Training.
- 34) Rectification of defects during Defects Notification Period.
- 35) Maintenance during Defects Notification Period.
- 36) Inspection and report during Defects Notification Period

C3.9.1.3 Detailed Technical Scope for Ebenezer Water Treatment Works (WTW)

C3.9.1.3.1 Civils and Process Works Technical Scope - WTW

The detailed civil and process works technical scope under the water treatment works includes:

- a. Lime Dosing System-** The lime dosing station is to be upgraded with the following equipment
- Hydrated lime storage silo with a capacity of 500 kg (approximately 3 day's supply) with a conical lower section at an angle of 70° to the horizontal.
 - Steel steps and a platform to facilitate emptying of 25 kg bags of lime into the silo, with appropriate dust control covers on the top of the silo.
 - Mechanical lifting device to lift 25kg bags of lime to the lip of the silo
 - The silo shall have a vibrating bin activator connected to the bottom of the silo cone
 - The bin activators shall incorporate a manually operated isolation knife-gate valve

Contractor

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- The silo shall be fitted with an electrically operated rotary valve, mounted beneath the knife-gate isolation valve, to maintain a regular flow of lime to mixing tank. The speed of the screw feeder must be adjustable via a variable speed drive, able to deliver up to 8 kg/h of dry hydrated lime.
- The dry hydrated lime shall be fed directly into a 1 000 litre mixing tank with a flow controlled water inlet and an impellor mixer to keep the lime in suspension (10%).
- A peristaltic pump suitable for pumping the lime slurry to the dosing point at a rate of up to 100 l/h.
- The existing lime dosing station shall be moth balled, with the lime slurry being pumped to this location (inlet to the cascade)

b. Polyelectrolyte Dosing Station - The following works need to be undertaken to upgrade the polyelectrolyte Dosing System

- Install feeder pipeline with hydrant connector (75 mm with adaptors to accommodate 50 mm, 75 mm and 100 mm to accommodate different tanker suppliers) to facilitate filling of 2 x 10 000 litre polyelectrolyte holding tanks.
- Replace the polyelectrolyte transfer pump (0.75kW)
- Install valves and related 25mm PVC piping on the transfer pump to be able to recirculate polyelectrolyte in each tank to facilitate mixing from time to time.
- Install 25 mm valve with clip-on 10 m detachable flexible hose to enable polyelectrolyte to be pumped to a vehicle mounted tank to supply to other water treatment operations.
- Replace duty and standby dosing pumps with suitable accurate metering pumps discharging up to 50 l/hour.
- Install an accurate flocculent flow rate meter
- Install a coagulant dispersion system to dose the coagulant evenly across the 1.8m flow channel.

c. Rapid Mix and Flocculation Channel - The existing flocculation channel does not promote the formation of larger stable flocs, and therefore following works need to be undertaken to construct a new rapid mix and flocculation channel to ensure improved floc development



Contractor



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Witness 1



Witness 2

- Installation of two Vee shaped baffles inside the flocculation channel immediately after the flocculent dosing point. These should be of galvanised steel and bolted into the floor and side walls of the flocculation channel. The baffles should each be half the width of the channel (0.9m), 0.7m high and with a Vee angle of 90° (45° to the wall). The Vee baffles are to be attached to opposite channel walls and stepped by 0.5m. The baffles are to be punched with 25mm holes at approximately 100mm spacing
- Construction of 40m of a parallel reinforced concrete channel 1.8m wide and 1.6 m deep incorporating side channel baffles for the development of flocs.
- Linking the new channel to the existing channel with a 90° bend and a 410mm step-down fall after the rapid mix section, then linking back into the existing channel at a 45° angle after the step
- Covering of the channel with metal gratings

d. Partial Replacement of Filter Sand With Anthracite Media - The aim of the replacement of 250 mm of the filter sand with anthracite media is to improve filtration effectiveness and particularly to extend filter runs before backwash requirements. The following works need to be undertaken to partially replace the filter sand in the filters

- Removal of 250 mm filter sand from each of the filters (approximately 15 m³ from each filter)
- Raising the overflow wall by 250 mm reinforced concrete anchored into the existing 10 600 x 250 mm wide walls.
- Carrying out a caustic wash of the remaining filter sand (150 kg caustic tablets per filter)
- Placement of a 300 mm anthracite layer on top of the sand bed in each filter. Each filter has a sand area of 58.8 m², and hence requires 17.6 m³ of anthracite. The anthracite layer has an effective size of 2.5 to 4.5 mm, and meets the specifications of hardness of 3 – 3.5 (Moh's scale) and a SG of 1.6.

e. Upgrading Of The Chlorine Dosing System - The chlorination station requires a thorough refurbishment. The following works need to be undertaken to refurbish the chlorine dosing station:



Contractor



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Witness 2



Employer



Witness 1



Witness 2

- Installation new dosing equipment - chlorine regulator, changer over devise/mechanism, chlorine gas flow measuring rotameters, etc. for the supply of 5 kg/h
- Feedwater pipe fittings replacement.
- Chlorine scale unit replacement (2 off) with digital reading.
- Leak detection and alert system
- Conversion of existing sodium hypochlorite room adjoining the chlorine dosing room to store full and empty chlorine cylinders.
- Upgrading of chlorine safety system in both the dosing room and the cylinder storage room.

f. Supernatant Return from Sludge Dam - The sludge dam settles out the solids in the filter backwash water, which results in a clear supernatant water that can be returned to the treatment works. Backwash water quantity is estimated as 5%, hence the supernatant recovery potential is approximately 2 000 m³/day. The pump at the sludge dams is no longer functional and needs to be replaced. In addition, a sump must be constructed opposite the inlet side of the dam to capture that supernatant water with a pump station to house the pumps. The pump station is not within the security perimeter of the treatment works and hence the pump station building must be highly secured. The following works need to be undertaken:

- Construction of a sump 4m x 2m x 2m deep with a 2m x 300mm screened inlet just below water level
- Construction of a secure pump station enclosure
- Power supply for the pumps

g. Service Water Supply For Plant And Housing - The service water supply for the plant and housing is to be replaced due to multiple corrosion related failures. The service water supply to the chlorination station is to be separated from the general service water supply system. The following works need to be undertaken:

- Installation of 100m of 40mm class 10 PVC water pipe from main pump station to the chlorine station
- A detailed assessment of the water pipe requirements for the service water supply to the plant and drinking water supply to the houses. Replacement of corroded pipeline with suitable PVC pipes.

Contractor

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Witness 2

- h. Required Materials and Equipment Specifications** - contractors with experience in supply, delivery; installation and commissioning of items as listed on the following summarized table, also refer to table under scope of work for detailed specifications:

Supply and Install	Number
Lime silo 500 kg capacity with supporting structure and attached vibrator	1
Lime screw feeder with capacity to feed 8 kg dry lime per hour	1
Steel structure for lime silo and screw feeder	1
Steel mixing tank with paddle mixer	1
Peristaltic pump 100 l/h	1
Lift for raising lime bags to lip of silo	1
Polyelectrolyte storage tank feeder pipeline with hydrant for delivery tanker	1
Transfer pump 0.75 kW	1
Valve and 10m flexible clip-on hose	1
Recirculation pipes and valves to facilitate mixing of polyelectrolyte in 10 000 liter storage tanks using existing transfer pump	2
Chemical metering pump with a capacity of 50 liter per hour	2
Flow meter on 25 mm polyelectrolyte dosing line to measure up to 50 l/h	1
1.8 m chemical feeder across flow channel	1
Construction of rapid mix and flocculation channel 40m long x 1.8 m wide x 1.6m deep	1
Vee shaped galvanized steel baffles 0.9m wide and 0.7m high attached to existing flow channel	2
Construction of 250mm high x 250mm wide walls on existing filter overflows 10.6m long	10
Removal and stockpile of filter sand 15m ³ per filter	150 m ³
Placement of filter graded anthracite in each filter (17.6 m ³ per filter)	176 m ³
Chlorine cylinder (1 ton) scales	2



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Supply and Install	Number
Chlorine dosing system to supply up to 5 kg/h with change-over facility	1
Upgrading of chlorine safety equipment	1
Modification of hypochlorite room for gantry and storage of full and empty cylinders	1
Concrete sump at sludge dam 4m x 2m x 2m deep	1
Secure pump station enclosure	1
Power supply for pumps	1
40mm class 10 PVC water pipe	100 m
Inspection and replacement of corroded water pipes	1

C3.9.1.3.2 Mechanical Works Technical Scope – WTW

The detailed mechanical technical scope under the water treatment works includes:

- Supply, delivery; installation and commissioning of new raw water inlet flow control valve, DN400, PN16
- Supply, delivery; installation and commissioning of new 316 stainless steel V-weir plates with notches /Cascade Aerator and refurbish aeration unit
- Supply, delivery; installation and commissioning of new 3 off 18000 BTU Air Conditioning units (split units) in control room and offices
- Supply, delivery; installation and commissioning of new 10 off of Drehmo DPMC 319B16 or equivalent electrically driven actuators on 10 backwash outlet valves
- Supply, delivery; installation and commissioning of new 10 off DN250 PN20 knife gate valves for filters backwash water inlet valves
- Supply, delivery; installation and commissioning of new 4 off DN150 PN10 butterfly valve filter air scour valves
- Supply, delivery; installation and commissioning of new 2 off horizontal centrifugal backwash pumps with shaft power of 15,5kW and being able to deliver 36,m³/h at head of 60m, with suction port of DN80 PN16 and delivery port of DN65 PN40.
- Manufacture, supply, delivery and installation of 2 off PN16 carbon steel reducers with one side being DN80 and being able to suit existing piping on the pump suction port
- Manufacture, supply, delivery and installation of 2 off PN40 carbon steel reducers with one side being DN65 and being able to suit existing piping on the pump delivery port



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Manufacture, modify, supply, delivery and installation of piping and specials to suit the supplied pumps and valves. Installation shall tie-in with an existing piping inside the backwash pump room. No piping shall be modified beyond backwash pump room.
- i. Supply, delivery; installation and commissioning of new 2 off 22kW horizontal backwash blowers similar/equivalent to an existing or latest version of 22kW Robuschi Blower 7" x 17". Blower shall be supplied together with its accessories such as pressure gauges, vibration sensors, temperature probes and other protection devices
- Supply, delivery; installation and commissioning of new 2 off horizontal backwash blower suction valves for the supplied valves. Valves diameters and pressure rating shall be as per the recommendation from blower OEM.
- Supply, delivery; installation and commissioning of new 2 off horizontal backwash blower delivery valves for the supplied valves. Valves diameters and pressure rating shall be as per the recommendation from blower OEM
- Manufacture, modify, supply, delivery and installation of piping and specials to suit the supplied blower and valves. Installation shall tie-in with an existing piping inside the backwash blower room. No piping shall be modified beyond backwash blower room.
- Design, manufacture, supply, install, testing and commissioning of new hoists and gantries for handling full chlorine gas cylinders and empty chlorine gas cylinders within chlorine dosing rooms.
- Installation of 2 off 2.5 ton with electrical power feed of 10m and 15m, electrically driven lifting crane on existing manual gantry
- Installation of an additional gantry from/to the adjoining sodium hypochlorite room for storage of full and empty chlorine cylinders (7m inside the room and 8m outside with 90 degree bend). The electrically driven crane should be rated for 2.5 tons
- Installation of 2 off 12kW submersible pumps (duty and standby submersible) to pump up to 2 MI/d at a static height of 25m through a 90mm HDPE pipeline of 250m length (static + hydraulic head = 35m)

C3.9.1.3.3 Electrical Works Technical Scope – WTW

The detailed electrical technical scope under the water treatment works includes:

- (i) Service Mini-substation for Domestic 6.6kV/400V 200kVA Miniature Substations
- (ii) Supply and installation of new Works 6.6kV/400V 500kVA Miniature Substation
- (iii) Service switchgear for Superfloc Dosing and Storage Distribution Board
- (iv) Undertake general electrical and energy efficient lighting:



Contractor



Witness 1



Witness 2



Employer



Witness 1



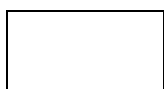
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- Replace old light fittings with T5 energy saving open channel and vapour proof fittings
 - Replace damaged and rusted power socket outlets.
 - Install occupancy sensors inside the offices to save energy.
 - Replace external flood lights with energy saving LED type
 - Testing entire installation and issue electrical certificate of compliance
 - Install two compartment power skirting to house exposed wires
 - Install cable trays to support wires
- (v) Replace Main Switchboard and MCC Panel for backwash blowers and Backwash Pumps and PLC Panels
- (vi) Replacement of Filter room Main 400V Panel and PLC Panels
- (vii) Supply and install actuated motors for 40 valves (backwash and air valves)
- (viii) Install street lights to enable sufficient lighting outside and all interior lighting
- (ix) Supply and installation of power and control cabling

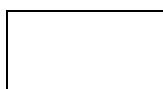
C3.9.1.3.4 **Electrical, Control & Instrumentation Works Technical Scope – WTW**

The detailed electrical, control and instrumentation technical scope under the water treatment works includes:

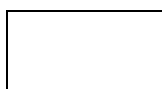
- Replacement and upgrading of Backwash Pumps and Blowers Main LV Board
- Replacement of Backwash Pump and Blowers Electric Motors
- Upgrade of the WTW PLC and HMI systems
- Automate all filter block valves by installing electrical actuators
- Install filter block Main LV Switchboard and PLC panels
- Upgrade Lime Dosing, Polyelectrolyte Dosing, Chlorine Dosing electrical, control and instrumentation systems
- Upgrade of Inlet Raw Water Valve and Meter electrical, control and instrumentation systems
- Upgrade the Control Room SCADA and SCADA Computers systems.
- Maintenance and refurbishment of miniature substation
- Maintenance and refurbishment of standby diesel generator system
- Supply and install 10kVA uninterruptible power supply (UPS) unit.
- Upgrade of Sludge Dam electrical, control and instrumentation systems including installation of 2 x submersible pumps
- Upgrade of borehole pumps control and instrumentation systems



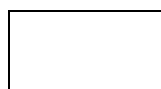
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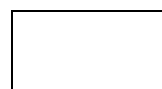
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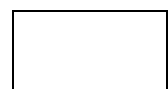
Witness 2



Employer



Witness 1



Witness 2

- Small power and lighting refurbishment including installation of energy efficient lighting.
- Earthing and lightning protection testing and repairing including issuing Certificate of compliance.
- Install new main inlet flowmeter.
- Supply New SCADA Software and Hardware in the Control Room where all monitoring and remote-control functions will be executed.
- Supply New SCADA system to read the status of all connected valves, reservoir and filter water levels, pumps and status of filters as specified.
- Linking all actuators for filter valves to the instrumentation and control monitoring system (PLC).
- Supply and install Uninterruptible Power Supplies (UPSs) for SCADA and telemetry equipment.
- Reconfigure new installed actuators.
- Upgrade blower house PLC old module
- Service and calibrate level monitoring instruments on the entire plant.
- Calibrate or install new water level transmitters on filters basins.
- Install new level transmitters on contact tank.
- Installation various Remote IO cards at various section of the plant and works to enable full PLC and SCADA control and automation.
- Backwash Reservoir Level Switch complete with all control cabling to enable to full operation and monitoring.
- Clean water reservoir Level switch complete with all control cabling to enable to full operation and monitoring.

C3.9.1.3.5 General Building Works Technical Scope – WTW

The detailed general buildings technical scope under the water treatment works includes:

- Modification of existing chlorine room into 3 off separate rooms, the rooms being full gas bottles storage room, in-use gas bottles operations room and empty gas bottles storage room
- Seal cracks in floor.
- Replace staircase handrail post.
- Replace the corroded door frames.

Contractor

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- Repaint the building externally to prevent further corrosion of steel sheeting cover.
- Replace corrugated sheeting to gables.
- Repaint the building externally.
- Replace the damaged purlins.
- Replace the damaged ceiling.
- Repair cracks in internal floor slab.
- Repair external concrete apron.
- Painting of walls and roof structures.
- Corrosion protection painting of steel structural work.
- Replacement of roof drainage gutters.
- Repairing of the peeling plaster.
- Installation of missing doors on buildings
- Installation of broken window pales
- Protect the exposed reinforcement on concrete roof slabs.
- Repair damaged brickwork on buildings

C3.9.1.4 **Detailed Technical Scope for Ebenezer High Lift Pump Station**

C3.9.1.4.1 **Mechanical Works Technical Scope – Ebenezer High Lift Pump Station**

The detailed mechanical technical scope under this pump station which includes working on an operational pumpstation (which must remain operational during construction) entails:

- Conduct pipe system curve verification tests to determine actual system curve when pumping to destination reservoir.
- Development of workshop drawings for approval by the employer
- Remove existing High Lift Multistage Centrifugal Pumps 1 - 4
- Remove all suction, non-return and delivery valves on centrifugal pumps 1 – 4
- Supply, Delivery to site, Installation and testing of a new Carbon Steel Flanged Reducing Tee piece from DN600 PN16 / DN350 PN16
- Removal of existing carbon steel reducers changes to DN300 / DN250 for lines 1 to 4, then deliver and off-load to the site which will be specified by LNW.
- Supply and installation of a new DN350 PN16 Dismantling Joint to be incorporated on the DN350 suction nozzle for the pump
- Remove existing DN300 suction wedge gate valves for line 1 to 4, then deliver and off-load to the site which will be specified by LNW.



Contractor



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Witness 2



Employer



Witness 1



Witness 2

- Supply, Installation and testing – DN350 PN16 Flanged Knife Gate Valve (Pump suction side) including bolts, nuts, gaskets and associated pipe fittings
- Remove existing multistage high lift pumps No.1 to No.4 , then deliver and off-load to the site which will be specified by LNW
- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 994m³/h against the Total Dynamic Head of 270m.
 - Level of Pump Axis = 1317.00 mASL
 - Lowest Suction Sump Level = 1318.00 mASL
 - Size of Suction Main = 500mm NB Steel
 - Length of Suction Main = <4m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
- Multistage Pumps Shaft Seals , Couplings and Safety Guards
- Each pump shall be driven by 1100kW Electric Motor (Motor specified below)
- Baseplates and anchor fasteners
- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty
- Supply and installation 4 off Carbon Steel Reducers - DN300 PN40 / DN350 PN40
- Replace 4 off non-return valves on all 4 pumps No.1 – No.4. by supplying, install, test and commission DN350 PN40 Nozzle type non-return valves on the delivery side within the pump station
- Supply, Delivery to site, Installation and testing of a new DN 300, PN 40 Nozzle check Non-return valve. Including Bolts and Gaskets
- Supply and installation of a new DN300 PN 40 Dismantling Joint to be incorporated on the DN300 delivery nozzle for the pump
- Supply , installation and testing of a new Isolation Delivery Side DN300 PN 40 Actuated Butterfly Valve.
- Modify all pipe spools lengths (SANS 719, Steel pipe, Flange on end) with PN16 flanges on suction side , PN40 flanges on delivery sides of the pumps and pipe lengths to suit the new valves and valves that will be supplied

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- Replace 4 off delivery valves on all 4 pumps No.1 – No.4. by supplying, install, test and commission of 4 off new Isolation Delivery Side DN350 PN40 Actuated Triple Eccentric Butterfly Valves on the delivery side within the pump station
- Supply and install DN350 PN40 Flange adapters on the delivery side within the pump station.
- Supply, installation and testing of 2 off new cooling water PN16, DN150 suction wedge gate valves
- Supply, installation, testing and commissioning of 2 off new cooling water pumps - 5,5KW Centrifugal pumps coupled with motors including couplings and safety guards. Pump shall be able to operate within maximum head of 20m at flow rate of 15 litres/min
- Supply and installation of new cooling water carbon steel pipes to the pumps and motors, cooling water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) on the 5 pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN150 on suction side and Carbon Steel Schedule 80 pipes PN 25, DN100 on delivery side.
- Supply and installation of 6 off new actuated motor cooling water valves – DN 50 suction and delivery solenoid valves
- Supply, installation and testing of cooling water PN 25 DN100 actuated delivery wedge gate valve
- Supply, installation and testing of cooling water DN 100 PN 25 wafer type non return valves
- Supply, testing and installation of 2 new off service water PN 16, DN200 suction wedge gate valves
- Supply, installation and commissioning of 2 off service water pumps - 32kW Centrifugal pumps (Flow Rate - 253 m³ per hour @ head = 29,22m) coupled with motors including Couplings, Safety Guards, Baseplates and anchor fasteners
- Supply and installation of 2 off new service water PN25, DN200 Wafer Type Non-Return valves
- Supply and installation of 2 off new service water PN25, DN200 actuated delivery wedge gate valves
- Supply and installation of new service water carbon steel pipes to the pumps, service water pipes shall be Schedule 80 (ANSI/ASME B36.10 Steel Pipes) for 2 off service pumps within the pump station. Carbon steel Schedule 80 pipes PN16, DN200 on suction side and Carbon Steel Schedule 80 pipes PN25, DN200 on delivery side.
- Clean dirt, remove paint, sand-blast, repair/weld worn sections and repaint all/entire pump station piping and flanges in accordance to pipe content colour coding SANS 1091 NATIONAL COLOUR CODING Standard

Contractor

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Employer

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- Design, manufacture, supply/deliver, install and commission surge tank outside the pump station and connect it to existing 600mm ND pipeline
- Supply and installation of a new 1 off DN 350, PN40, SANS 719, Steel pipe, 6m lengths to fabricate new pipe spools as and when required for delivery
- Supply and installation of a new 1 off DN 350, PN25, SANS 719, Steel pipe, 6m length to fabricate new pipe spools as and when required for suction piping systems
- Supply and Installation of a new 10 off new DN 350, PN 40, single weld on Flange for pump station modifications
- Supply and Installation of a new 10 off new DN 350, PN 40, single weld on Flange for pump station modifications
- Supply and install 5 ton electric wire rope hoist to an existing gantry system. The crane system shall be able to travel transverse and longitudinal through travelling trollies
- Servicing, testing and certification gantries and lifting equipment for high lift pump station- Cross Travel Main Gantry Crane installed on the beams
- Provide equipment data packs for supplied and installed equipment
- Provide practical field training to LNW personnel involved in maintenance & operations of the high lift pump station
- Provide maintenance services to the high lift pump station for minimum of 6months duration after construction completion but before pump station hand-over.

EBENEZER SYSTEM CURVES



Contractor



Witness 1



Witness 2



Employer



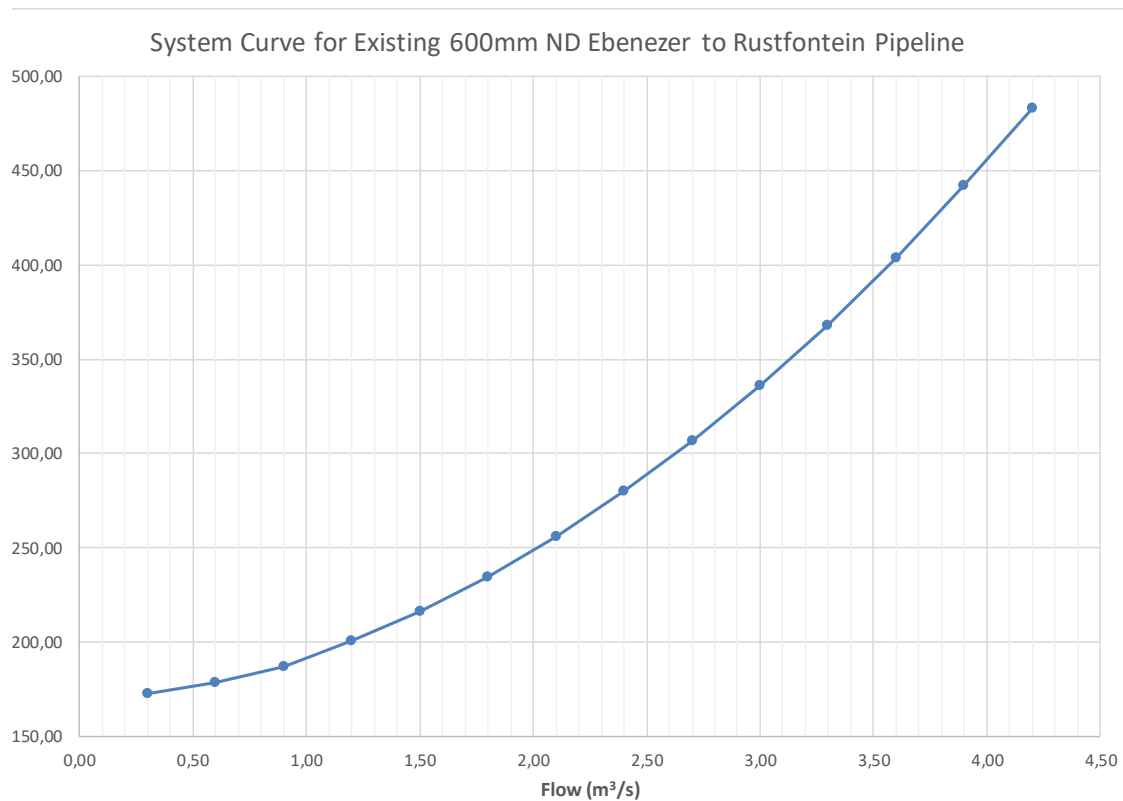
Witness 1



Witness 2

Existing 600mm ND Ebenezer to Rustfontein Pipeline - System Table

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,30	172,30
0,60	178,40
0,90	187,00
1,20	200,55
1,50	216,17
1,80	234,70
2,10	256,00
2,40	280,00
2,70	306,90
3,00	336,00
3,30	368,00
3,60	404,00
3,90	442,00
4,20	483,00



Contractor

Witness 1

Witness 2

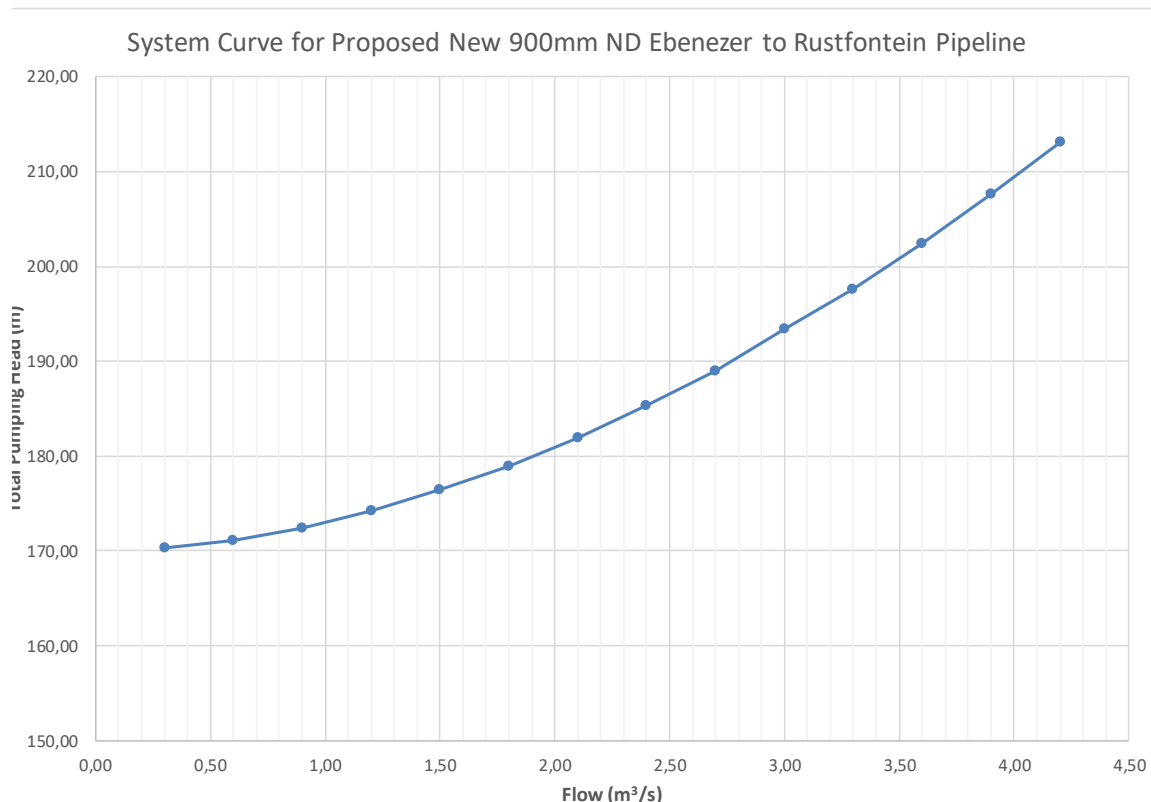
Employer

Witness 1

Witness 2

Proposed New 900mm ND Ebenezer to Rustfontein Pipeline - System Table

Design flow (m ³ /s)	Total pumping head, H _t (m)
0,30	170,30
0,60	171,10
0,90	172,40
1,20	174,20
1,50	176,40
1,80	178,90
2,10	181,90
2,40	185,30
2,70	189,04
3,00	193,40
3,30	197,60
3,60	202,40
3,90	207,60
4,20	213,14
4,50	219,00
4,80	225,30
5,10	231,00



Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.9.1.4.2 Electrical Works Technical Scope – Ebenezer High Lift Pump Station

The detailed electrical technical scope under the high lift pump station includes:

- Decommission and removal of Pump 1 – 4 6.6kV 560kW Electric Motors
- Decommission and removal of Pump 1 – 3 Soft Starters
- Decommission and removal of Pump 4 6.6kV Auto- Transformers
- Supply and installation of New Multi-speed 6.6kV 1100kW Water Cooled Electric Motors for new High Lift Pump (Pump 1-4)
- Supply and installation of 6.6kV 1100kW/1475.1HP Variable Frequency/Speed Drives (VFD/VSD) for all pump motors (Pump 1-4)
- Supply and installation of 6.6kV 836kW/1121.1HP Variable Frequency/Speed Drives (VFD/VSD) for all pump motors (Pump 1-4)
- Decommission and remove of Pumps 5(A+B) and 6(A+B) power factor correction units
- Supply and install 6.6kV XLPE cables due to new positions of the VFD/VSD
- Supply and install low voltage power and control cables
- Condition assessment testing of High Lift Pump 6.6kV Switchgear
- Supply and installation of Main Pump Station LV Board and PLC Panels
- Supply and installation of new 500kVA 6.6kV/400V Miniature Substation
- Refurbishment of LV Distribution Boards (Service Water pumps and Cooling Water pumps)
- Install electrical actuators on Rustfontein valves then integrate the valves to Ebenezer High Lift Pump SCADA and Telemetry system
- Supply and installation of 10kVA 3-in/1-Out) UPS Unit
- Pump station lighting replacement and small power
- Pump station earthing and lightning protection

C3.9.1.4.3 Electronic, Control & Instrumentation Works Technical Scope – Ebenezer High Lift Pump Station

The detailed electronic, control & instrumentation technical scope under the high lift pump station includes:

- Design, manufacture, supply, install and commissioning of 400V Main Switchboard and PLC Panels
- Upgrade Pump Station SCADA and Telemetry System
- Replacement of all field instruments such as flow meters, vibrations sensors, etc



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Develop control philosophy to ensure integration of pump and valves proper starting sequence of pumps, actuated valves, VFD/VSD where installed etc.
- Replacement of Main Pump Station PLC including all programming of field instruments and Station HMI Unit
- Automate all cooling and service water pump and isolating valves
- Replacement of Pump-Set PLC Systems (6 off)
- New SCADA Software and Hardware in the Control Room where all monitoring and remote-control functions will be executed
- Telemetry system equipment

C3.9.1.4.4 Civils and General Building Works Technical Scope - Ebenezer High Lift Pump Station

The detailed civils and general building works technical scope under the high lift pump station includes:

- Minor plastering repairs
- Painting Works
- Minor steel works

C3.9.1.5 Detailed Technical Scope for Rustfontein Reservoirs

C3.9.1.5.1 Mechanical Works, Electrical and Control & Instrumentation Technical Scope Rustfontein Reservoirs

The detailed mechanical, electrical and control & instrumentation technical scope under the high lift pump station includes:

- Replacement of 3x DN 900 & 1x DN 300 outlet Butterfly valves at the Rustfontein Reservoirs and associated actuators.
 - a) Supply and install DN900 PN10 butterfly valves with actuator at Rustfontein Reservoirs.
 - b) Supply and install DN300 PN10 butterfly valve with actuator at Rustfontein Reservoirs
- Remote IO and Telemetry system for the Rustfontein reservoir and power supply for the actuators and control cabling

C3.9.1.6 Configuration, Installation & Testing



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The design of the installation shall provide for the completed installation to be suitable **for testing to ISO 9906 Acceptance grade 2B** on Site during commissioning.

C3.9.1.7 **Witness Testing and Factory Inspections**

The Contractor shall allow for the Engineer and Engineer's representatives to travel from Johannesburg and the Employer and Employer's representatives to travel from Polokwane for all witness testing and factory inspections and Employer's representatives to travel from Polokwane for all witness testing and factory inspections.

C3.9.2 **Process and Control**

C3.9.2.1 **General**

The Contractor is responsible for providing the control functions described below.
The detailed requirements for electronic equipment are specified elsewhere.

C3.9.2.2 **PFDs and P&IDs**

The P&IDs shown on drawings explains the overall system.

C3.9.2.3 **Water Sources, Reservoirs and Network for Ebenezer Scheme**

To be discussed with Appointed Contractor prior to commencement of construction

C3.9.2.4 **Pump Control**

C3.9.2.4.1 ***Modes of operation (future and emergency)***

The Water Treatment Plant and High Lift Pump Station shall have 3 modes of operation. The mode selection shall be done on the equipment's respective control panels.

a) **Manual/maintenance mode**

In this mode equipment shall be controlled from the switchgear panel or MCC and only the essential protection (safety interlocks) shall be active in this mode. This mode is selected by setting the local/remote switch on the equipment panel to *local*. A special key shall be required to switch to manual/maintenance mode.

b) **Semi-Auto Mode**

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

In this mode equipment are controlled by the PLC control system and all protection (safety and process interlocks) shall be active. Equipment e.g. the pumps can be started from the pumpset HMIs via the PLC control system in this mode. This mode is selected by setting the local/remote switch on the equipment panels to *remote*.

c) Auto / SCADA Mode

This mode is similar to the previous mode, but now equipment can be controlled via the local SCADA in the control room.

C3.9.2.4.2 Ebenezer Water Treatment Plant and High Lift Pump Station Operation

Water treatment plant will produce potable/drinking water, which is abstracted from Ebenezer dam, treated water will then be transferred to Ebenezer Treatment Works main reservoir or contact tank.

The pump station shall be automatically controlled based on water levels in the Suction and Command Reservoir. If the water level in the command reservoir is low (<75%) and the water level in the suction reservoir is sufficient (>20%) the pumps shall be started. The control system shall monitor the water levels in the reservoirs and stop the pump if the water level is above 95% (high) in the command reservoir (future) and/or below 20% (low) in the suction reservoir.

The Contractor shall provide hydrostatic level meters in the Suction Reservoir and Command Reservoir and shall transmit these levels to the pump station for incorporation into the control system. The level meters shall also be used for providing alarms for low level and high level in the reservoirs. Loss of communication shall not prevent automatic operation of the pump station from continuing.

In addition to the level monitoring, a level switch shall be provided in each reservoir for low level protection in the Suction Reservoir and high level protection in the Command Reservoir.

C3.9.2.4.3 Pump Station Operation (Emergency Supply)

The pump station control as part of the emergency supply shall be similar to that of the future scheme described above except for the following:

- c) The pump station shall continue to operate as long as the water level in the Suction Reservoir is sufficient (>20%).

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

d) The pump station shall stop when the water level in the Suction reservoir is insufficient (<20%).

C3.9.2.4.4 **Normal Start Up**

A pumpset shall start through Variable Speed Drives with the suction side isolation valve open and the actuated delivery isolation valve closed. The actuated delivery isolation valve shall start to open upon the pump receiving a start signal and shall open over a period of approximately 60 seconds (minimum of 30 seconds, to be confirmed during Commissioning).

A second pumpset shall also start in this manner but only once the first pump actuated delivery isolation valve is fully open.

A third pumpset shall also start in this manner but only once the second pump actuated delivery isolation valve is fully open.

The fourth pumps with the least number of operating hours shall become the duty pumps. The pump with the least number of operating hours shall become the first DUTY pump and the pump with most operating hours shall be the first to be a STANDBY pump.

C3.9.3 **General Mechanical Requirements**

The Works shall comply with Mech 0001 for the following general requirements:

- Materials
- Castings
- Fabrication of steels
- Welding
- Installation
- Civil and building works
- Pipework supports
- Base frames
- Machine guards
- Shaft couplings
- Gearboxes
- Bearings
- Lubrication
- Gauges
- Fasteners
- Machine vibration
- Noise control
- Spares
- Signage

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.9.4 Multi-Stage Horizontal Centrifugal Pumps

PS 10.4.1 Specification

The pumps shall be multi -stage, ring-section centrifugal units with horizontal shaft and shall comply with Mechanical Specifications. The multi-stage centrifugal pumps shall further comply with following specifications:

- suction nozzle on drive-end, and positioned horizontal (90 right from Drive-end DE)
- Discharge nozzle on Non-Drive-End (NDE) and positioned horizontal (270° from DE)
- Bronze Impellers (or 316 Stainless Steel), casted units and balanced (cert 3.1 / 2)
- Bronze or suitable diffusers
- Rotating assembly dynamically balanced
- Pump must be hydrostatically tested at 110% it's maximum rated pressure (at least) or 120 maximum duty pressure
- Pump set Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty
- Pumps to be able to be operated through the utilization of Variable Speed Drives /Variable Frequency Drives.
- Pump Critical Speed at least 125% above maximum speed of maximum duty.
- PT100 Bearing Temperature Sensors on both Bearings (DE & NDE) with 4-20mA transducers to SCADA
- Vibration Sensors on both Bearings (DE & NDE) Signal to SCADA
- Casing Temperature Sensor PT100 with 4-20mA signal to SCADA

Treated drinking water will be pumped from Ebenezer Water Treatment Works Contact Tanks/Reservoirs/Suction Reservoirs and be pumped to Command Reservoirs at Rustfontein reservoirs complex located on R528 towards Polokwane city.

C3.9.4.2 Amendments, Additions and Detailed Requirements

- i. Ebenezer Treatment Works - The Contractor shall provide various water treatment mechanical, electrical and instrumentation equipment as shown on the drawings. The Contractor shall provide all items specified for treatment works
- ii. Ebenezer High Lift Pumps Station - The Contractor shall provide 4 pumpsets as shown on the drawings. The Contractor shall provide all items specified for each pumpset. The items for each pump set includes:



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

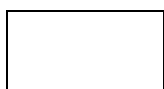
- a) Pump.
- b) Pump motor.
- c) Base frame and anchor fasteners.
- d) Shaft coupling.
- e) Shaft/coupling guard.

Items required for the pumpsets but also specified elsewhere are as follows:

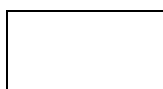
- a) Insertion magnetic flow sensor.
- b) Pressure gauges.
- c) Pressure transmitters.
- d) Pipework.
- e) Flange adaptors.
- f) Suction isolation flanged knife valve.
- g) Discharge isolation Actuated Butterfly Valve gate valve
- h) Nozzle check Non-return valve
- i) Electrical and control equipment.

C3.9.4.3 Performance Requirements

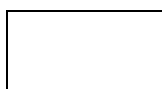
- Supply, installation, testing and commissioning of High Lift Multistage Pump as detailed below:
 - Each Multistage Pump must be able to deliver 994m³/h against the Total Dynamic Head of 270m.
 - Level of Pump Axis = 1317.00 mASL
 - Lowest Suction Sump Level = 1318.00 mASL
 - Size of Suction Main = 500mm NB Steel
 - Length of Suction Main = <4m
 - Each Pump shall have a minimum efficiency of 80%
 - Each pump shall be supplied with all protection devices such as vibration sensors, casing temperature sensor, DE & NDE bearing temperature sensors
 - Multistage Pumps Base-plate, Shaft Seals , Couplings and Safety Guards
- Each pump shall be driven by 1100kW Electric Motor (Motor specified below)
- Baseplates and anchor fasteners



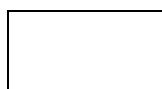
Contractor



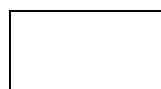
Witness 1



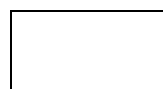
Witness 2



Employer



Witness 1



Witness 2

- Conduct Pump Testing & Certification - Hydrostatic test at 110% of its maximum rated pressure and Performance tested to ISO 9906 1U, or at least ISO 9906 1B with no negative tolerances for Efficiency on duty

C3.9.5 Eccentric Axis Actuated Butterfly Valves

PS 10.5.1 Specification

Butterfly isolation valves shall comply with DWS 2510.04.

Electric actuators shall comply with DWS 2510.02.

Corrosion protection shall comply with DWS 9900 C7.

Installation work shall comply with Mech 0001.

This valve shall be Double eccentric butterfly valve to EN 593 for neutral liquids like drinking water

Design standards:

- EN 593
- Face-to-face dimension according to EN 558 Table 2 Basic Series 13
- Flange drilling to EN1092, PN10/16

Test/Approvals:

- Hydraulic test according to EN 1074-1 and 2 / EN 12266
- Approved for drinking water according to WRAS

Component list:

1.Body	Ductile iron GJS-500-7 (GGG-50)	16.	Thrust bearing	Bronze
2.Shaft, drive	Stainless steel AISI 420	17.	End plate	Ductile iron GJS-500-7
3.Bearing	Bronze/PTFE composite	18.	Washers	Stainless steel A2
4.O-rings	EPDM rubber	19.	Bolts	Stainless steel A2
5.Bolt, socket head	Stainless steel A2	20.	Nut	Stainless steel A2
6.Cover	Stainless steel	21.	Seal retainer ring	Stainless steel
7.Gasket	EPDM rubber	22.	Seal ring	EPDM rubber
8.Key	Stainless steel A2	23.	Gearbox	Cast iron
9.Set screws	Stainless steel A2			
10. Disc	Ductile iron GJS-500-7			
11. End cover	Stainless steel			
12. Screw	Stainless steel A2			
13. Shaft, stub	Stainless steel AISI 420			
14. Seal ring	EPDM rubber			
15. Spacer	Bronze			

C3.9.5.2 Scope



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The valves shall be installed as shown on the drawings.

The valves shall be provided with electric actuators. Actuated valves shall be provided with manual override. Actuators shall also be provided with manual start and stop functions at the valve.

The Contractor shall make all arrangements and carry all transport and accommodation costs for the Engineer and one representative of the Employer to witness the testing of the valves at the manufacturer's premises.

The Contractor shall make arrangements for the Engineer to inspect and witness the testing of the valves for compliance prior to payment being made. If the valves are manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for the Engineer and one representative of the Employer to inspect and witness the testing of the valves in the workshop prior to despatch to Site. If the valve is not manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for an Engineer approved inspection authority to inspect and witness the testing of the valves in the workshop prior to dispatch. The inspection shall include a full report on compliance with this specification and this report shall be submitted to the Engineer prior to dispatch of the unit from the workshop.

Test certificates shall be submitted to the Engineer for all valves.

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.

C3.9.5.3 **Amendments, Additions and Detailed Requirements**

C3.9.5.3.1 General (Clause 1)

The valves shall be of the double eccentric, resilient seal type.

The valves shall be suitable for the flow, internal pressure and differential pressure conditions of the pumping system which is specified elsewhere in PS9.

These valves will be open under normal operating conditions.

They will generally be used for maintenance purposes and will not be operated on a regular basis.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The valve 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 Africa. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable. Valves which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

Valves shall seal drop tight in the required direction(s) at the PN rating of the valve.

It shall not be possible to damage any component by over-torquing.

Motor driven gearboxes shall comply with the requirements for motor driven gearboxes in Mech 0001. Gearbox service factors shall be chosen in accordance with this specification or shall comply with the guidelines of AGMA.

Manual gearboxes shall comply with the requirements for manual gearboxes" in Mech 0001.

C3.9.5.3.2 Construction and Operational Requirements (Clause 2)

Handwheels shall be clockwise closing. A slipping clutch or equivalent mechanism shall prevent over-torque which would cause damage. Torque limiting devices which have to be replaced after activation, such as shear pins, are not acceptable.

The main seal shall be uncompressed when the valve is open. It shall be replaceable by removing the retaining ring.

The shaft shall be provided with o-ring seals. The valve shall incorporate provision for attaching limit switches for signalling valve fully open and valve fully closed.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the disc when it is subjected to a differential pressure equal to the rated pressure difference across the disc. Handwheels shall not require a peripheral force greater than 250 Newtons (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons).

Valves shall comply with the following additional requirements:

- d) Valves shall be provided with a bypass. The bypass pipework shall be flanged pipework and a flanged stainless steel ball valve shall be provided on the bypass.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- e) Valves shall have the manufacturer's name, size, working pressure and flow direction integrally cast with the valve body.
- f) Manually operated gearboxes shall be provided with a stainless steel grease nipple.

C3.9.5.3.3 Valve Material Specifications (Clause 3)

Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be completely clear of ferrous stain and heat tint at commissioning.

Carbon steel parts (wrought) are not acceptable either internally or externally. This includes high tensile items such as pins, roll pins, dowels etc.

- Electrolytically applied plating of ferrous materials is not acceptable.
- The application shall be taken into account in the corrosion protection of valves.
- Handwheels shall be of cast or forged metal (cast iron or aluminium) or shall be of stainless steel.
- All other external metal components shall be of EN Grade 1.4401 (316).
- Materials shall comply with the requirements for material in Mech 0001. Delete Sub-Clause 3.3 to 3.5.
- The valves shall be lined with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a top coat of pure aliphatic polyurethane to a minimum dry film thickness of 25 micron.
- The valves shall be coated with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a re-coatable top coat of polyurethane to a minimum dry film thickness of 40 micron.

C3.9.7 WEDGE GATE VALVES

C3.9.7.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.09 - WIMES 8.09, issue 01 January 2014

C3.9.8 Nozzle Check Valve

C3.9.8.1 Specification

- Nozzle check valves shall comply with Mech 7012.
- Corrosion protection shall comply with DWS 9900 C7



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.9.8.2 Amendments, Additions and Detailed Requirements

C3.9.8.2.1 Scope of Works (Clause 2)

DN350, PN 64 rated double flanged nozzle check valve with spring closing shall be provided in the discharge manifold. The valve shall be of the "Noreva Nozzle Check Valve" type or similar approved. The valve shall be provided with a proximity switch to indicate no flow. The valve shall be installed as per drawings.

C3.9.8.2.2 Performance Requirements

The valves shall be suitable for the flow, internal pressure and differential pressure conditions of pumping system which is specified elsewhere in PS9.

C3.9.8.2.3 Design and Construction

The valve will close when the pump station is not operational.

The valve shall be designed for non-slam closure

C3.9.8.2.4 Materials and Coatings

The valves shall be lined with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a top coat of pure aliphatic polyurethane to a minimum dry film thickness of 25 micron.

The valves shall be coated with a fusion bonded epoxy to a minimum dry film thickness of 250 micron and a re-coatable top coat of polyurethane to a minimum dry film thickness of 40 micron.

C3.9.8.2.5 Installation

The valves shall be positioned at least 6 x DN value of the discharge manifold downstream of the ultrasonic flow meter.

Check valves shall be separated from downstream isolation valves by a distance of at least 1,5 times the pipe diameter.

C3.9.8.2.6 Testing Requirements



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The Contractor shall make all arrangements and carry all transport and accommodation costs for the Engineer and one representative of the Employer to witness the testing of the valves.

C3.9.8.2.5 Installation

The valves shall be positioned at least 6 x DN value of the discharge manifold downstream of the ultrasonic flow meter.

Check valves shall be separated from downstream isolation valves by a distance of at least 1,5 times the pipe diameter.

C3.9.8.2.6 Technical Data Sheet for Nozzle Check Valves

Contract shall fill-in the technical information for the product offered for this tender.

C3.9.9 SWING CHECK NON-RETURN VALVES

C3.9.9.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.09 - WIMES 8.09, issue 01 January 2014

C3.9.10 PENSTOCKS, STOPGATES AND HANDSTOPS

C3.9.10.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.10 - WIMES 8.10, issue 01 January 2014 or later

C3.9.11 AIR BLOWERS

C3.9.11.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.04 - WIMES 8.04, issue 03, March 2012 or later

C3.9.11.2. Scope of Works (Clause 2)

Supply of 2 off blowers for water sand filters with the following minimum requirements: Design Type – Horizontal mounted, Maximum Flow – 857 CFM, Motor Size – 22KW, Gear Diameter- 5 inch, Maximum Speed – 2 850 RPM, Minimum Speed – 763 RPM, Temperature Rise - 125°C, Delta Pressure – 7PSI/483 mbar, Inlet Vacuum – 500 mbar, Max Vacuum – 15” Hg, Drive End Lubrication- Grease, Gear End Lubrication – Oil.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The blowers shall be provided with all protection devices such as over-pressure, vibration sensors, high temperature sensor/ thermocouples.

C3.9.11.3 Performance Requirements

The blower shall be suitable shall be able to meet the:

- (i) Inlet vacuum – 500mbar
- (ii) Minimum speed – 763 revs/min
- (iii) Maximum speed – 2 850 revs/min

C3.9.11.4 Design and Construction

The blower will stop and start depending on air demands on sand filters.

C3.9.11.5 Testing Requirements

The Contractor shall make all arrangements and carry all transport and accommodation costs for the Engineer and one representative of the Employer to witness the testing of the blowers. Contractor shall notify the Engineer and Employer about the intention to conduct tests at least 1 week in advance.

C3.9.12 MECHANICAL INSTALLATIONS

C3.9.12.1 Specification

Refer to Water Industry Mechanical And Electrical Specifications 8.03 - WIMES 8.03, issue 04, August 2016 or later

C3.9.10 Pipework Supports

C3.9.7.1 Specification

Pipework supports shall comply with Mech 7024



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.9.7.2 **Amendments, Additions and Detailed Requirements**

C3.9.7.2.1 Performance Requirements

The Contractor shall provide all pipe supports required to adequately secure the pipework and shall anchor these pipe supports (to suitable concrete structures) in order to satisfy the performance requirements specified.

The contractor shall provide all supports required to adequately secure the suction isolation valves, plunger valves and discharge manifold nozzle check valve.

C3.9.7.2.2 Construction and Design

The pipework supports shall be made from Grade S355JR or better (in terms of yield strength).

The Contractor shall provide all forces acting on pipework supports, and valve supports to the Engineer for design of the concrete plinths.

C3.9.7.2.3 Corrosion Protection

Pipe supports shall be hot dip galvanized and shall comply with DWS 9900 C7.

C3.9.7.2.4 Inspections

The Contractor shall make arrangements and carry all transport and accommodation costs for the Engineer to inspect the pipe support fabrications before they are corrosion protected

C3.9.8 **Couplings and Flange Adaptors**

C3.9.8.1 **Specification**

Flange adaptors shall comply with Mech 7023.

C3.9.8.2 **Amendments, Additions and Detailed Requirements**

C3.9.8.2.1 Scope

The Contractor shall provide flange adaptors for misalignment and dismantling purposes

C3.9.8.2.2 Performance Requirements

The flange adaptors shall have the same pressure rating as the parent pipe.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.9.8.2.3 Construction and Design

The adaptor body and end ring shall not be made of castings, but shall be fabricated items

C3.9.8.2.4 Corrosion Protection

Corrosion protection shall comply with DWS 9900 C7.

Couplings and flange adaptors shall be lined and coated with fusion bonded epoxy to a minimum dry film thickness of 300 microns.

C3.9.8.2.5 Inspections

The Contractor shall make arrangements for the Engineer to inspect the couplings and flange adaptors before they are corrosion protected.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10 SPECIFICATIONS

SEC	DESCRIPTION	PAGE
PSM	PARTICULAR SPECIFICATIONS FOR MECHANICAL REFURBISHMENT AND UPGRADE WORKS	C3.10-4
MECH 0001	GENERAL MECHANICAL REQUIREMENTS	C3.10-5
MECH 0002	OPERATING AND MAINTENANCE MANUAL	C3.10-47
MECH 1001	PERMANENT LADDERS	C3.10-51
MECH 1003	LIFTING EQUIPMENT	C3.10-54
MECH 7012	NOZZLE CHECK VALVE	C3.10-67
MECH 7112	BUTTERFLY VALVES	C3.10-73
MECH 7023	PIPE COUPLINGS	C3.10-91
MECH 7024	PIPEWORK SUPPORTS	C3.10-94
MECH 10010	PUMP STATION (MULTI-STAGE CENTRIFUGAL PUMPS)	C3.10-98
PSE	PARTICULAR SPECIFICATIONS FOR ELECTRICAL REFURBISHMENT AND UPGRADE WORKS	C3.10-119
PSE - 01	PARTICULAR SPECIFICATION FOR 6.6kV HIGH LIFT PUMP ELECTRIC MOTOR RATED UP TO 2000kW (2682HP)	C3.10-120
PSE - 02	PARTICULAR SPECIFICATION FOR MEDIUM VOLTAGE ADJUSTABLE FREQUENCY/SPEED DRIVES RATED 224 kW (300HP – 7 457kW (10,000HP)	C3.10-126
PSE - 03	PARTICULAR SPECIFICATION FOR ONSITE TESTING, MAINTENANCE AND REFURBISHMENT OF MV ELECTRICAL SWITCHGEAR AND ASSOCIATED EQUIPMENT	C3.10-152

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EPS-08	ELECTRICAL MEDIUM VOLTAGE SWITCHGEAR	C3.10-271
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PSCI	PARTICULAR SPECIFICATIONS FOR CONTROL AND INSTRUMENTATION REFURBISHMENT AND UPGRADE WORKS	C3.10-335
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PSM: PARTICULAR SPECIFICATIONS FOR MECHANICAL REFURBISHMENT AND UPGRADE WORKS

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C3.10.1 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.

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



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- BS 2789

- BS 3100

- BS 3790

- BS 4515

- BS 4872

- 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.

3. 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

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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 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.

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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 for the coating system to be applied.

4.3 Austenitic Stainless Steels

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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.

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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 Sigmeline 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.

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. Discolouration and steel contamination must be removed by pickling or electro cleaning as approved by the Engineer but should rather be avoided by taking the appropriate measures.

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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.



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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 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 ± 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.



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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.

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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 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

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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.

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Witness 1

Witness 2

10.3 Pump 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.

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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 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



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Witness 2



Employer



Witness 1



Witness 2

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.

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.



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Witness 2



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Witness 1



Witness 2

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.



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- 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

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]				
	<i>flow = 0 - 2,5 l/s</i>	<i>flow = 2,5 - 15 l/s</i>	<i>flow = 15 - 100 l/s</i>	<i>flow = 100 - 500 l/s</i>
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.

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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 "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.

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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

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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.

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

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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.

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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, 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.

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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.
- 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.



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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 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



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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.



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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.

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.



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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.

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



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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) 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



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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.



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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 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



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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 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



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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:

$$T_{trip} = T_{equilibrium} + (40^{\circ}\text{C} - T_{ambient}) + 10^{\circ}\text{C}.$$

(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.

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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 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



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Witness 2



Employer



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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.

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.

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- 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.



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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.

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



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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 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.



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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.

Where hook bolts are used, these shall be supplied and grouted by the Contractor into pockets which



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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

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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.

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.



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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 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 Leq 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.

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 $0,040 \text{ W/m }^\circ\text{K}$ 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.

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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.

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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.
- 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.

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C3.10.2 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.

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.

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4. Format and Contents

The Manual shall comply with the following format:

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NO	HEADING	CONTENT
1	General	
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. 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.
2	Operation	
2.1	Training Manual	Brief description of the complete operating system containing: Start-up , adjustment, operating and shut-down procedures for manual and automatic operation - Emergency operating procedures - Process verification - Settings , setpoints, protection, alarms and trips. A paper copy of this document shall be provided to each trainee.
2.2	Commissioning	Trainee attendance registers & Commissioning results.
3	Maintenance Schedule	
		Schedule of routine maintenance for all mechanical, electrical, instrumentation and control equipment, broken down into daily, weekly, monthly and annual periods. The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual. The schedule shall include all lubrication periods, lubricants and capacities.
4	Mechanical Equipment	
4.1	Equipment item 1 (e.g. pumps)	- The make, model, serial number, description, size, design range, performance data, motor and drive details and supplier's details of the item. - Dimensioned drawing. - A photograph of the nameplate. - Manufacturer's operating and maintenance manual. - Operating curves, test results, etc.
4.2	Equipment item 2 (e.g. mixers)	ditto



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4.3	etc.	ditto
5	Electrical Equipment	
5.1	Equipment item 1 (e.g. transformer)	As for 4.1 above; <i>PLUS</i> : Control and electrical details, including logic sequence, circuit diagrams and software, as applicable - Electrical reticulation drawings - Equipment overall dimensions - Wiring diagrams - Switchboard layout drawings - SLDs .
5.2	Equip. item 2 (e.g. VFCs)	ditto
5.3	etc.	ditto
6	Instrumentation Equipment	
6.1	Instrumentation Equip. Item 1 (e.g. Magflo)	As for 4.1 above; <i>PLUS</i> : 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
7	Control	
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.
8	Documents	
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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Witness 2



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		and date of manufacture.
8.3	Other	P rotection relay settings and test certificates - L ist of spares provided - C ertificate of electrical compliance - C orrosion protection systems used - C oating supplier's data sheets and coating repair procedures.

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C3.10.3 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
- 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).



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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.

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Ladders with a height greater than 10 metres shall be provided with intermediate landings which are spaced apart by not more than 8 metres.

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).



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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.

C3.10.4 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,



Contractor



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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 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.



Contractor



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Witness 2

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.

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



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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.

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).



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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.

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

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Employer

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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.

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



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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.

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



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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 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.

Contractor

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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

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.



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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

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.



Contractor



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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. 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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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.



Contractor



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Fasteners which secure crawl beams shall be provided with spring washers in addition to the flat or fender washer.

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



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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.

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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C3.10.5 PARTICULAR SPECIFICATION: MECH 7012: NOZZLE CHECK VALVE

1. Introduction

Mech 7012 specifies the requirements for nozzle check valves with spring closing to be provided by the Contractor and which are designed for rapid shut-off in order to prevent the start of reverse flow in water pipelines with pressure ratings up to PN 64.

2. Scope of Works

This Specification covers the design and manufacture of nozzle check valves with spring closing required along the rising main for this Contract. The installation shall be configured as shown on applicable drawings.

3. Normative References

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Mech 7012).
- Mech 0001: General Mechanical Requirements.
- Mech 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Mech 7024: Pipe Supports.
- SANS 1123: Pipe Flanges.
- SANS 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- National Occupational Health and Safety Act and Regulations.
- SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. Equipment Eligibility

The make and model of valve 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 acceptable.

Valves which do not satisfy these requirements are not acceptable unless called for in the specifications or unless the Engineer agrees in writing.



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5. Performance Requirements

The valve shall be rapid closing. It shall close within the specified time for closing, if applicable. The installed valve shall close before flow reversal can occur. The check valve shall open when the velocity in the pipeline exceeds 0.3 m/s.

Valves shall be sized to open fully at the low point of the system's flow range. Fluttering shall not be acceptable.

The body shall withstand the internal pressure rating.

The valve shall meet the leakage rate allowed by SANS 1551-1 for flap valves.

The complete system shall be capable of performing reliably at any point in the specified range.

Valves shall be of the nozzle type with the internal flow path (Disc & sealing) being of a Venturi design resulting in a low pressure drop with the closure member (Disc) moving in an axial direction.

In response to flow reversal a compressed spring initiates valve closure providing a quick response. The closure time should be guaranteed by the manufacturer and should be in the Millisecond time span.

6. Design and Construction

The valves shall be PN 64 rated for Olifantspoort Pump Station 1 and be PN40 rated for Olifantspoort Pump Station 2 & 3 as well as Ebenezer High Lift Pump Station. Flanges shall be drilled to BS EN 1092 and where flanges are not covered by the BS EN 1092 standard, ASME B16 47 shall apply for the relevant pressure class. Where detailed on the drawing, a bypass pipeline shall be installed.

Bodies shall be of ductile iron, cast steel or of cast stainless steel. Seats and seals shall be of stainless steel. The valves shall be double flanged.

The pressure rating shall suit the application but shall not be less than 10 bar.

Stainless steel spring(s) shall close the disc or disc ring prior to reverse flow starting. The spring(s) shall be suitably rated for the duty so that the valve closes prior to the onset of reverse flow.

The disc or disc ring shall close under reverse flow even if a spring has broken. Guides shall be specifically designed to be non-sticking.

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Valves shall be double flanged. The valve shall be of the long body type, i.e. shall not be of the short body type unless called for in the project specification.

Indelible body markings shall include the manufacturer's name, pressure rating (PN), nominal size (DN) and the direction of flow.

Valves of DN 150 and larger shall incorporate a bypass with a small bore isolating wedge gate valve.
Fasteners shall comply with Mech 0001.

7. Instrumentation

One pressure gauge shall be provided upstream of the valve, and one shall be provided downstream of the valve. Instrumentation shall comply with Mech 0001.

8. Materials and Coatings

8.1 General

Valve bodies and discs shall be Ductile Iron to GGG 50, 300 micron minimum fusion bond epoxy powder coated internally and externally.

All SS internal components and internal SS fasteners, where possible shall be 2 pack Epoxy coated after assembly to prevent galvanic action between the SS components and the body/disc.

All coatings shall be pin-hole free.

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Mech 0003. Materials shall comply with Mech 0001.

8.2 Equipment

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Body	Cast steel or cast iron.	Protected by a coating with a dry film thickness no less 300 micron and suitable for immersion. Two pack, solvent free wet applied coatings are acceptable but fusion bonded coatings such as FBE or Rilsan or equivalent are preferred
	Stainless steel.	N/A



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ITEM	MATERIAL	COATING
Body fasteners	EN Grade 1.4401 (316)	
Flange fasteners	As specified for pipework.	As specified for pipework (but at least hot dip galvanised, i.e. not black bolt and coated).
Auxiliary metal components	EN Grade 1.4401 (316)	Pickle and passivate.
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		
Metal plating of ferrous materials is not acceptable as the corrosion protection system.		
Steel and cast iron items which have been hot dip galvanised, but which are then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.		

8.3 Fasteners

Fasteners shall comply with Mech 0001.

8.4 Spares

The spares to be provided are specified elsewhere

8.5 Installation

Installation work shall comply with Mech 0001.

The Works shall comply with the following:

When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

The Contractor is responsible for grouting work associated with the equipment and pipework to be provided in terms of the Contract.

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

Crevice which are formed between two metal surfaces shall, prior to final fastening, be filled with a suitable packing, Denso tape or equivalent, or with a suitable mastic or sealant.”

Thrust supports shall be provided unless the pipework is specifically designed to restrain the thrust forces arising from valve closure.

A straight, constant diameter pipe with a length of at least four times the pipe diameter shall be provided between upstream pumps, valves or bends. A straight, constant diameter pipe with a length of at least 1,5 times the pipe diameter shall be provided between the check valve and downstream valves.

Orientation of the valve shall comply with the manufacturer's recommendation.

The Contractor shall ensure that the corrosion protection coatings are not damaged during transport and installation.

8.6 Safety

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

8.7 Inspections

8.7.1 Workshop / Factory

The Contractor shall arrange for fabrications to be inspected by the Engineer for acceptance after fabrication is complete but prior to corrosion protection.

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. 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

8.7.2 Site

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site for acceptance prior to commissioning.

8.7.3 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.

8.8 Testing Requirements

8.8.1 Factory, etc.

The Contractor shall make all arrangements and shall be responsible for all costs for attendance of the Engineer at the witness tests specified.

Valves to be coated shall be tested after the coating systems have been applied. Bodies shall be pressure tested to at least 110 percent of the design pressure.

Leak testing shall be done to ensure compliance with the manufacturer's guarantee.

The Contractor shall submit reports for all specified factory tests to the Engineer prior to the equipment being transported to Site and prior to payment being made.

8.8.2 Site

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

9. Measurements and Payment

The rates for valves shall cover the cost of the provision of each valve, complete with couplings and valve supports, and the cost of delivering the valves to site and temporary storage thereof, installation, testing and commissioning.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.6 PARTICULAR SPECIFICATION: MECH 7112: BUTTERFLY VALVES

1. General

1.1 Type

Butterfly valves shall be of the double flanged, bi-directional, full-bore and “tight shut off” type.

Resilient seal valves shall be of at least the double eccentric type. Metal seal valves shall be of the triple or quad off-set type. Seal requirements shall be as specified in the Project Specification.

Manufacturers shall certify in the Technical Schedule (paragraph 3.3) that the valves offered are of a double eccentric, triple or quad off-set design.

Wafer and lug type butterfly valves not exceeding 300 mm diameter may be considered for temporary and/or low cost application.

1.2 Specifications

Butterfly valves shall generally be in accordance with BS EN 593: 2009 and EN 558 series 13.

1.3 Flow Rates

The maximum flow velocity through a valve shall not exceed 7 m/s unless otherwise specified in the Project Specification. No cavitation in the fully open position shall be accepted. The maximum permissible flow rate at the maximum differential pressure across the valve and the head loss for the specified flow rate shall be stated in the Technical Schedule.

1.4 Operation

A butterfly valve shall close under the maximum specified head and flow rate and shall be functional in any position without variation of the blade position or flutter. Normal operation shall however be in either the fully open or fully closed position.

There shall be no interference in the water flow pattern through a valve except for the blade.

The blade shall close with a positive action with no possibility of slamming shut during any stage of the closing operation. The backlash in the gearbox shall be limited to less than 5 degrees on the handwheel.

A butterfly valve shall be installed in a position allowing the valve to operate along the horizontal axis. The lower portion of the blade shall open towards the downstream side of the valve i.e. in the direction of flow



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

1.5 General Requirements

The seat and seal shall be of a design preventing the rings from becoming loose and obviate water seepage under the seals or seats during all conditions of operation and testing. Removable seats shall be assembled with solvent free epoxy on the interface.

The inner diameter of the exposed face of the mounting flange of the removable seat or seal in the body shall either be stainless steel deposit welded and machined to the same level of the seat, or the seat ring shall be manufactured to cover the seat mounting flange. Detail of the mounting flange shall be submitted on the detail drawing. The mounting flange shall be fitted with jacking bolts to ease removal of the ring.

A minimum coating overlap of 5mm on valves up to DN 500 and 10mm on larger valves is required on the stainless steel and ductile/cast steel interfaces.

2. Construction and Operational Requirements

2.1 Body

The hubs for the shaft-bearings and the gearbox mounting flange shall form an integral part of the valve body. A ten (10) millimetre wide and five (5) millimetre deep drain groove shall be machined in the gearbox mounting flange to release any seepage water in the event of shaft seal failure.

The preferred flow direction shall be indicated by an arrow on the casting.

2.2 Blade

The blade shall be a single casting or fabrication of optimum hydrofoil section with a smooth continuous surface. The maximum combined stresses in the blade shall not exceed 20% of the yield stress of the material when the design pressure is applied on any of the two sides.

The following surfaces of the blade shall be weld deposited with stainless steel 309L or better (1,5mm minimum thickness):

- 10mm under the resilient seal.
- The inside edge that is in contact with the stainless steel retaining ring (machined to a size to avoid damage to the coating of the corrodible blade material).
- The edge of the blade to a width of 15mm on valves up to DN 500, 25mm on DN 600 to DN 1 200 valves and 50mm on valves above DN 1200.

Details of the weld deposit areas shall be submitted with the Tender on the detail drawing.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

2.3 Seal Retaining Ring

The seal retaining ring, manufactured from stainless steel 304 S15 or better, shall be coated in accordance with the Corrosion Protection Specification to reduce galvanic corrosion.

2.4 Seat and Seal

2.4.1 Resilient Seal Valves

Resilient seal valves shall have a resilient seal arrangement that is removable and replaceable in situ and adjustable from the downstream side of the valve, without having to remove the valve from the pipeline. If so specified the seal must be located and adjustable from the upstream side of the valve.

A single moulded music note, or T-section type resilient seal is required for a valve specified for high velocity applications.

The resilient seal shall have non-weathering, non-sticking, long life properties and shall be compatible with the quality of water to be conveyed.

The sealing faces in the body shall either be replaceable or be weld deposited (2mm thick minimum) with stainless steel 309L (or better), be accurately machined and polished and shall provide adequate "lead in" for the resilient seal to open and close only on a stainless steel seat.

The recess for the seal and retaining ring assembly in the blade shall be coated in accordance with the specified corrosion protection specification. The resilient seal shall be assembled with a coat of wet solvent free Epoxy.

2.4.2 Metal Seal Valves

2.4.2.1 General

Metal seal valves shall be of at least triple off-set design to prevent damage to the metal seals.

The 6mm (minimum thickness) 316 S15 stainless steel and PTFE/Graphite laminated sealing ring or better, mounted either on the blade or the body as specified in the Project Specification, shall be secured with a stainless steel 304 S15 or better retaining ring and stainless steel A4-70 fasteners.

The sealing ring thickness shall be designed to ensure a long reliable service life. Dimensionally thin rings shall not be accepted.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The sealing rings shall be easily replaceable. A spare sealing ring shall be supplied with each valve. The clamp and sealing rings shall be marked with the appropriate mounting position to ease installation when required.

The seating faces shall either be replaceable and secured with stainless steel fasteners or be weld deposited (2mm thick minimum) with stainless steel 309L or better, be accurately machined and polished for a drop tight seal.

Clear, concise and easy to follow installation and setting instructions to fit replacement sealing rings shall be specified in the Operation and Maintenance Manual.

The mounting surfaces on the body or blade of the seat and sealing rings shall be stainless steel 309L (or better) deposit welded to prevent contact between the surfaces of stainless and lesser noble materials. Details of the arrangement shall be submitted by the Contractor for the Engineers approval.

The structural test of the blades shall be tested separately to 1.5 x the maximum permissible working pressure.

2.4.2.2 Quad Off-set Valves

There shall be no friction between seal and seat until full contact in the closed position and the valve shall have very low torques due to the 4th offset.

The blade shall be floating on the shaft to assist with drop tight closure. Sealed bearings are preferred.

2.5 Mechanical Stops

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.

2.6 Shafts

Shafts shall either be continuous or of a stub-shaft design configuration. Stub shafts shall extend into the blade hubs for a distance of at least 1.5 shaft diameters and shall not protrude from the hubs i.e. exposing the shaft.

Shafts shall be attached to the blade by means of keys, dowel pins, taper pins or any combination of the three. The connection shall be designed to transmit the maximum torque that may be applied to the shaft and a shaft torque equivalent to at least 75% of the torsional strength of the shaft. Dowel and taper pins, manufactured from stainless steel, shall be mechanically secured.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The idle shaft cover shall be manufactured from stainless steel and secured with stainless steel fasteners or mild steel incorporating a full face bronze thrust bearing and secured with hot dip galvanized fasteners.

2.7 Bearings

Self-lubricating sleeve type bearings (bronze backed) or bushes shall be fitted in 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 blade securely concentric with the seat.

2.8 Position Indicators

To simulate the blade position, the pointer of the indicator fitted to the drive shaft shall point in the flow direction when the valve is in the open position. The pointer shall accurately indicate the position of the blade.

2.9 Gearboxes

All gearboxes shall conform to project specifications

3. Valve Material Specification and Test Pressures

Valve components, unless otherwise specified in the Project Specification, shall be constructed of the material and tested as specified in sections 3.1 and 3.2. The structural test shall comply with clause 2.4.2.1.

3.1 Double Flanged Butterfly Valve (DN 200-3000)

3.1.1 Test Requirements for Resilient Seal Valves

SIZE DN	PRESSURE RATING (kPa)	HYDRAULIC TEST PRESSURE (kPa)		
		STRUCTURAL	SEAL SETTING	SEALING
200 – 3 000	1 000	1 500	1 100	1 000
200 – 2 500	1 600	2 400	1 760	1 600
200 – 2 000	2 500	3 750	2 750	2 500
200 – 1 500	4 000	6 000	4 400	4 000
200 – 1 500	6 400	9 600	7 040	6 400

NOTE: Butterfly valves specified to be bi-directional shall be pressure tested from both sides.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

3.1.2 Test Requirements for Metal Seal Valves

SIZE DN	PRESSURE RATING (kPa)	HYDROSTATIC TEST PRESSURE (kPa)	
		STRUCTURAL	SEALING
200 – 3 000	1 000	1 100	1 000
200 – 2 500	1 600	1 760	1 600
200 – 2 000	2 500	2 750	2 500
200 – 1 500	4 000	4 400	4 000
200 – 1 500	6 400	7 040	6 400

NOTE: Where specified in the Project specification, metal seal butterfly valves shall be tested from both sides.

3.1.3 Material Specification

COMPONENT	MATERIAL TYPE	MATERIAL SPECIFICATION (or Better)
BODY	SG IRON	SANS 936 Gr SG420/12 / ISO 1083 Gr JS-500-15S
	CAST STEEL	BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr
		C3/ SANS 1465 Part 3 Gr CRS 6
	MILD STEEL	SANS 50025-2/EN 10025-2 Gr S350JR
BLADE	SG IRON	SANS 936 Gr SG420/12 / ISO 1083 Gr JS-500-15S
	CAST STEEL	BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr
		C3/ SANS 1465 Part 3 Gr CRS 6
	MILD STEEL	SANS 50025-2/EN 10025-2 Gr S350JR
BODY/BODY SEAT	STAINLESS STEEL	BS 970 Part 4 Gr 309L S15
		INCONEL 625
BLADE / BODY SEAL	EPDM 75°A / NITRILE RUBBER	BS EN 168-1 TYPE WA



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

COMPONENT	MATERIAL TYPE	MATERIAL SPECIFICATION (or Better)
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	BS 1400 PB1C (Cu, Sn10, P)
	SLEEVE TYPE	BRONZE BACKED (DUB)
SHAFT SEALS	RADIAL LIP SEAL / CUP SEAL /	NITRILE / VITON
	O-RING SEAL	
IDLE SHAFT COVER	STAINLESS STEEL	BS 970 Part 4, Gr 304 S15
IDLE SHAFT THRUST BEARING / SPACER DISC	PHOSPHOR BRONZE	BS 1400 PB1C (Cu, Sn10, P)
EXTERNAL FASTENERS	STEEL (HOT DIP GALVANIZED)	SANS 1700 (SANS 121, ISO 1461)
	STAINLESS STEEL	ASTM A193 Gr B8M
INTERNAL FASTENERS	STAINLESS STEEL	ASTM A193 Gr B8M

3.2 Resilient Seal Wafer and Lug Type Butterfly Valve (DN 50-300)

3.2.1 Test Requirements for Wafer and Lug Type Valves

SIZE DN	PRESSURE RATING (kPa)	HYDRAULIC TEST PRESSURE (kPa)		
		STRUCTURAL	SEAL SETTING	SEALING
50 – 300	1 000	1 500	1 100	1 100
50 – 300	1 600	2 400	1 760	1 760
50 – 300	2 500	3 750	2 750	2 750
50 – 300	4 000	6 000	4 400	4 400

NOTE: Wafer and lug type butterfly valves shall be tested from both sides.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

For test purposes a blank flange shall be fitted to the valve on the one side and with a ring flange on the opposite side of the valve.

3.2.2 Material Specification

COMPONENT	MATERIAL TYPE	MATERIAL SPECIFICATION (or Better)
BODY	SG IRON CAST STEEL MILD STEEL	SANS 936 Gr SG420/12 / ISO 1083 Gr JS-500-15S BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6 SANS 50025-2/EN 10025-2 Gr S350JR
BLADE	SG IRON CAST STEEL MILD STEEL	SANS 936 Gr SG420/12 / ISO 1083 Gr JS-500-15S BS 1504-161 Gr 480 / SANS 1465 Part 1 Gr C3/ SANS 1465 Part 3 Gr CRS 6 SANS 50025-2/EN 10025-2 Gr S350JR
BODY SEAT	STAINLESS STEEL	BS 970 Part 4, Gr 309L
BLADE / BODY SEAL	EPDM 75°A / NITRILE RUBBER	BS EN 168-1 TYPE WA
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	BS 1400 PB1C (Cu, Sn10, P) BRONZE BACKED (DUB)



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

COMPONENT	MATERIAL TYPE	MATERIAL SPECIFICATION (or Better)
SHAFT SEALS	RADIAL LIP SEAL / CUP SEAL / O-RING SEAL	NITRILE / VITON
IDLE SHAFT COVER	STAINLESS STEEL	BS 970 Part 4, Gr 304 S15
EXTERNAL FASTENERS	STEEL (HOT DIP GALVANIZED) STAINLESS STEEL	SANS 1700 (SANS 121, ISO 1461) ASTM A193 Gr B8M
INTERNAL FASTENERS	STAINLESS STEEL	ASTM A193 Gr B8M

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

3.3 Technical Schedule for Specification

_____ mm NB BUTTERFLY VALVE

REFERENCE: _____

Complete in block letters

(Failure to complete all relevant sections of this form may result in the Tender being disregarded.)

GENERAL

Brand or model

2. Manufacturer's name and
Address of Local Workshop

3. Country of manufacture: Casting
Body and Blade

Assembly

4. Agent's name

5. Is valve manufactured under licence?

YES/NO *

6. Name of firm responsible for licence

7. Is the Tenderer a bona fide valve supplier?

YES/NO *

8. Does the Tenderer have his own manufacturing
and service workshop in S.A. with regard to the equipment offered?

YES/NO *

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

9. Does the Tenderer offer a local service and spare

parts network?

YES/NO *

10. Number and date of similar butterfly valves

manufactured and installed in South

Africa _____ VALVES

VALVE

11. Type: Double / tripple / quad

12. Design pressure (PN)

_____ kPa

13. Test Pressure: Structural Test

_____ kPa

Seal Sealing Test

_____ kPa

14. Metal seal blade test pressure

_____ kPa

15. Flange drilling table

16. Gross mass of completely assembled valve

_____ kg

17. Maximum flow rate through valve

_____ m/s

18. Head loss through valve at maximum flow

_____ mm wg

19. Flange to flange dimension

_____ mm

20. Are horizontal spindles offered?

YES/NO *

21. Are welders coded?

YES/NO *

22. Materials of construction:

Valve body

Valve disc

Valve shaft

Non-drive end cover plate

Valve seat

Resilient seal

Metal seal

Seal retaining ring

Journal bearings (state type if applicable)

Disc shaft pin / key

Shaft bearing seals

Internal fasteners

External fasteners

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

DRIVE SYSTEM

23. Make and type of *electric actuator /
*hydraulic power pack / *gearbox _____
24. Gross mass of complete unit _____ kg
25. Handwheel diameter / hand pump lever length _____ mm
26. Force on handwheel rim / hand pump _____ N
required for manual operation
27. Number of *handwheel turns / *hand pump strokes _____
or *revolutions to open valve manually
28. Gearbox ratio _____
29. Time to fully open valve manually _____ sec
30. Time to fully open valve electrically/hydraulically _____ sec
31. Type of position indicator _____
32. Details of all safety features incorporated _____

33. Type of water repellent grease (attach data sheets) _____
34. Make and type of hydraulic cylinder _____
35. Material of manufacture _____
36. Type of seal on piston _____
37. Number of hydraulic cylinders _____



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

38. Maximum hydraulic pressure to open and close valve _____ / _____ kPa

39. Maximum hydraulic pressure supplied by power pack _____ kPa

40. Means of switching hydraulic supply between valves _____

41. Hand pump *stroke and lever length/ _____ mm _____ mm
*force on handle and length _____ mm _____ mm

Power rating of electric actuator motor / pump motor _____ kW

Is electric actuator / power pack protected against

the ingress of moisture? State IP rating

YES/NO *

IP _____

44. Automatic phase rotation correction

YES/NO *

45. Type of "torque trip" indication

CONTRACTUAL

Is the Offer fully compliant with the requirements of Project Specifications?

YES/NO *

47. Deviations from Specification

(Also refer to Annexure 1.)

48. *Amendment(s) Number

_____ Received/No amendment(s)

*DELETE WHICH IS NOT APPLICABLE

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Spare Parts Price List

The Tenderer shall propose and submit a price list for all programmed maintenance and strategic/breakdown spares for the valve(s) together with actuator(s). These spares shall be manufactured concurrently with the contract. Such spares shall be supplied to site as may be ordered and at the prices quoted in this schedule. The Total Price for spares is to be excluded from the Total Tender Price but the necessary spares will be ordered with the main items of the tender.

Item	Quantity	Type or	Description	Delivered to site price
		Serial No		(Including VAT) ZAR

*Total Price R_____

Name of Tenderer (block letters) _____

Signature of Tenderer _____

Tel _____

Fax _____

Date _____

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.10.7 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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 (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

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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.

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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.8 PECIFICATION: 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,

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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.

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.

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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 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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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C3.10.9 SPECIFICATION: MECH 10010: PUMP STATION (MULTI-STAGE CENTRIFUGAL PUMPS)

1. Introduction

Mech 10 010 specifies the standard requirements for pump stations with horizontal shaft, multi-stage, ring-section centrifugal pumps. It applies to pump installations which are driven by electric motors or driven by diesel engines which are either permanently installed or are mounted on moveable skid base frames.

Water to be pumped includes both treated water and raw water. It does not include water which contains solid matter that could snag on pump inlet vanes, butterfly valves, check valve spiders, etc. but does include raw water which has small amounts of grit and dissolved solids. The temperature will not exceed 24°C at the pump inlet.

2. Scope of Works

See project specification. The installation shall be configured as shown on applicable drawings.

3. Normative References

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Mech 10010).
- Mech 0001: General Mechanical Requirements.
- Mech 0002: Operating and Maintenance Manual.
- Mech 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Mech 1003: Lifting Equipment.
- Mech 7001: Design and Manufacture of Medium-Pressure Steel Pipework Specials.
- Mech 7012: Nozzle Check Valves for Water.
- Mech 7014: Eccentric Axis Butterfly Valves..
- Mech 7023: Couplings and Flange Adaptors.
- Mech 7024: Pipe Supports.
- SANS 1123.
- BS EN 1092.



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Witness 2



Employer



Witness 1



Witness 2

- ISO 9906.
- National Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. Equipment Eligibility

The 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. Performance Requirements

5.1 System

The system shall be capable of performing the specified pumping duties.

5.2 Equipment

5.1.1 General

Each item of equipment shall comply with the performance requirements of the relevant Mech spec.

Each shall be rated for continuous operation at the specified duties unless otherwise specified.

All components shall perform reliably over the specified range.

5.1.2 Pump

During performance testing at the guarantee point(s), the guaranteed performance for differential pressure across the pump, volume flow, energy efficiency and $NPSH_{required}$ shall be confirmed within the standard's tolerances for the Acceptance grade specified.

6. Operation and Control

6.1 General

Control functions specified in the Mech specifications for individual items of equipment shall be complied with.

Manual start and stop of each item of powered equipment shall be provided. Protections shall be active

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during manual operation.

Motor driven pumps shall be designed to shut down safely and without damage upon failure of the electrical supply.

Each pumpset shall be provided with an emergency stop station in an appropriate position near the unit.

6.2 Pumpsets

6.2.1 Alarm & Shut-Down

The Contractor shall provide protection against:

- Low flow in each pump.
- High flow in each pump.
- Suction and/or discharge valves not fully open.
- High discharge pressure.
- Low suction pressure.
- Low discharge pressure.
- High pump bearing temperature.
- High motor bearing temperature or high engine coolant temperature, whichever is applicable.
- Low engine oil pressure (if applicable).
- High temperature in room (if applicable).
- Low flushing/cooling water flow to seals.

6.2.2 Bearing Temperature

6.2.2.1 Pumps

Pump bearing temperature shall be monitored and indicated.

The Contractor shall note the bearing temperature after 30 minutes of normal operation and shall also note the ambient temperature. The high level shut-down temperature shall then be calculated as follows:

$T_{\text{shut-down}} = T_{\text{equilibrium}} + (40^{\circ}\text{C} - T_{\text{ambient}}) + 10^{\circ}\text{C}$. The pump shall shut down if $T_{\text{shut-down}}$ is reached.

6.2.2.2 Motors

Bearings of electric motors shall be provided with the same temperature protection as the pump bearings.

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6.2.3 Pumpsets Larger than 450 kW

Pumpsets larger than 450 kW shall be provided with protection against the following additional conditions:

- Vibration severity high at each pump bearing.
- Vibration severity high at each electric motor bearing.

Vibration measurement in either the horizontal or the vertical direction shall be acceptable.

7. Configuration and Design of Pump Station

7.1 General

The configuration shall be as shown on applicable drawings.

The pumpsets shall be mounted with shaft horizontal. Drive shall be direct, via a shaft coupling.

Pipework shall be horizontal and shall be mounted approximately 300 mm above the floor level. If vertical pipework is unavoidable, this shall be mounted against a concrete wall.

7.2 Valves

Isolation valves and check valves shall be installed in horizontal pipework. Each valve shall be supported.

The forces from check valves shall be restrained. These forces shall not be transferred to the pump flanges.

Valve handwheels shall preferably be accessible by an operator standing on the floor. If this is not feasible, the Contractor shall provide hot-dip galvanised platforms for safe access to operate the valves. Guard rails and grid flooring shall comply with Mech 0001.

7.3 Requirements for Testing on Site (Pumps > 250 KW)

Pumpsets larger than 250 kW shall be performance tested on Site for power demand, flow, head and efficiency at the specified guarantee point. Testing shall be in accordance with ISO 9906 and shall comply with Acceptance grade 2B for head, flow and efficiency.

The pipework configuration, instrumentation and all other aspects shall be designed accordingly in

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order to provide this requirement.

8. Pumps

8.1 General Requirements

Pumps shall be multi-stage, horizontal shaft, ring-section centrifugal pumps.

The inlet and outlet shall be oriented horizontally unless otherwise specified or shown on the drawings. The inlet and outlet shall be flanged. The flanges shall be dimensionally compatible with SANS 1123 or BS EN 1092; plate flanges for welding. Flanges on pumps with PN 25 rating and higher shall have raised faces.

Shaft sleeves shall be provided. The pumped fluid shall not come into contact with the shaft at any point.

Pumpset speed shall not exceed 1 500 rpm.

Pump final stage casings shall have the same pressure rating as the discharge pipework.

The pump nameplate shall be of stamped or engraved stainless steel and shall state the manufacturer, model, year, serial number, inlet diameter, outlet diameter, duty point head and flow (or range), impeller diameter, speed, maximum allowable casing pressure and mass.

A vent cock shall be fitted.

The body shall be provided with lifting lugs.

8.2 Operational Requirements

The Contractor shall select the pump so that the specified operating point is to the left of the pump's best efficiency point for the chosen impeller size and speed (unless the Engineer accepts that there is another overriding technical factor which affects the choice of pump).

The specified operating points shall be within the pump manufacturer's recommended continuous operating range for the pump.

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The pump shall have a shut off head at least fifteen percent higher than the specified duty head. The fully assembled pump casings shall be designed to withstand the specified test pressures.

The rotating assembly shall be designed to have its first critical speed at least 25% above the maximum operating speed.

Rotating elements shall be balanced, and the level of vibration severity used for the design shall not exceed VRMS = 1 mm/s at the bearings. Alternatively, measured vibration severity in Zone A or Zone B of ISO 10816 is acceptable.

8.3 Castings

Castings shall be sound and free of shrink or blow holes.

Scale, blisters, flashing and other sharp edges and defects shall be fettled and rounded off.

The impeller and the diffusers shall have a smooth finish. Indentations, pits, hollows and welding shall not be acceptable. Grinding and machining of the impellers and the diffusers is acceptable.

8.4 Wear Rings

The casing shall be provided with replaceable wear rings.

The impellers shall be provided with replaceable wear rings.

8.5 Materials

Pump impellers and diffusers shall be of aluminium bronze or of CF-8M stainless steel (the cast equivalent of EN Grade 1.4401 (316)). The Contractor shall provide impeller and diffuser material of a higher abrasion resistance than aluminium bronze and CF-8M if the fluid to be pumped contains abrasive material, e.g. river water.

The pump shaft shall be of chrome steel or of stainless steel.

Metallic wear rings shall be of stainless steel or of a non-ferrous metal. Materials shall be non-corroding in the pumped fluid. Casing wear rings and impeller wear rings shall not be of the same material and shall have significantly different hardness. Preferred wear ring materials are stainless

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steel mated with a thermoplastic composite such as DuPont Vespel, or equivalent.

Shaft sleeves shall be of stainless steel.

Anchor fasteners shall be of EN Grade 1.4401 (316) or of a duplex stainless steel.

8.6 Corrosion Protection

8.6.1 General

All components shall be designed for long term corrosion resistance in the environment. Corrosion Protection shall comply with Mech 0003.

8.6.2 Wetted Surfaces

Pump bodies shall be provided with corrosion resistant coatings over their wetted surfaces. This does not include impellers and diffusers. The system's nominal dry film thickness shall be about 500 microns. The system used shall be specifically suitable for pump internals such as a solids bearing vinyl ester acrylic copolymer such as Corrocoat Polyglass VEF or a ceramic coating such as Belzona 1321 or equivalent.

Where abrasion resistance is required, a suitable coating shall be provided over the pump's wetted surface (excluding impellers and diffusers which shall be of materials chosen for abrasion resistance). The system's dft shall not be less than 1 200 microns. The coating shall be specifically suitable for pump internals such as a solids bearing vinyl ester copolymer of about 1 500 microns such as Corrocoat Armagel, or a ceramic carbide such as Belzona 1811/1812 or equivalent.

The coatings shall be applied in accordance with the coating supplier's method statement. Surface preparation cleanliness shall, however, comply with Sa 3, regardless of the supplier's minimum recommendation.

8.7 Shaft Couplings

Shaft couplings shall incorporate elastomer elements and shall comply with Mech 0001.

8.8 Bearings

8.7.1 General

Bearings shall be mounted external to the pump casings.

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Bearings shall shut down safely and without damage when the driver shuts down under any condition. Bearings shall be provided with seals to prevent ingress of dust and sprayed water. Bearings shall comply with Mech 0001.

8.7.2 Type

Bearings for units of 500 kW and larger shall be plain bearings. Bearings for smaller units shall be of the type recommended by the pump manufacturer, i.e. either plain or rolling element.

8.7.3 Rolling Element Bearings

Rolling element bearings shall be designed for an L-10 life of not less than 100 000 hours.

Bearings shall be oil lubricated, and the oil bath shall be provided with a level sight glass. If the Engineer agrees that the bearings may be grease lubricated, then the bearing housing shall be provided with a stainless steel nipple and an outlet port for the exhaust of excess grease.

8.7.4 Plain Bearings

Air cooling is preferred for plain bearings.

Oil-ring lubrication is preferred for plain bearings.

More complex methods of cooling and lubrication are acceptable if recommended by the pump manufacturer.

8.9 Shaft Seals

8.9.1 General

Pumps shall be provided with mechanical seals unless otherwise specified. The seals shall be pressure rated for the application.

A pump in series with another pump shall be provided with shaft seals which have a pressure rating higher than the shut-off pressure of the pump immediately upstream.

8.9.2 Mechanical Seals

Mechanical shaft seals shall be of the cartridge type, shall be suited to the application and the face

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materials shall be of silicon carbide or of tungsten carbide.

8.9.3 Gland Packing

If shaft gland packing is specified, this shall be provided with a lantern ring and water lubrication. The packing shall preferably be PTFE based but shall be suited to the application.

The shaft shall be protected against wear by a replaceable stainless steel shaft sleeve.

8.9.4 Water Supply to Seal

Water from the discharge side of the pump may be used for flushing/cooling water on condition that filtration (or a suitably designed cyclone arrangement) is provided and designed to remove solids from the water. The filter (or cyclone) shall be provided by the manufacturer of the seal.

A flow sensor shall be provided in the pipework between the filter (or cyclone) and each shaft seal, and these shall be incorporated into a protection system to prevent dry running.

Stainless steel ball isolation valves shall be provided to enable the filter (or cyclone) and the flow sensor to be serviced without having to shut the pump's main isolation valves. Valves shall be lockable in the open position. Corrosion resistant padlocks shall be provided.

If a cyclone is used, its underflow may be piped to return to the suction pipework. Pipework shall be of stainless steel and shall be rigidly supported.

9. Valves

9.1 Isolation Valves

One isolation valve shall be provided on the suction pipework of each pump. One isolation valve shall be provided on the discharge pipework of each pump.

One pump station isolation valve shall be provided for isolating the pump suction manifold (unless the configuration does not incorporate a suction manifold). One pump station isolation valve shall be provided on the discharge manifold.

Isolation valves shall either be butterfly valves or shall be metal seated wedge gate valves. Butterfly valves shall be of the eccentric disc type, shall be double flanged and shall comply with Mech 7014.

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Metal seated wedge gate valves shall be double flanged and shall comply with Mech 7015.

9.2 Check Valves

9.2.1. Nozzle Check Valves

A check valve shall be provided on the discharge leg of each pump.

Check valves shall be of the nozzle check type.

The manufacturer shall provide a detailed reference with full contact details in order for the purchaser to verify the actual operation of the valves. Suppliers failing to supply the requested references may have their tender rejected.

Nozzle check valves shall comply with Mech 7012 and shall be double flanged

9.2.2. Double flanged Tilting Disc Non Return Valves

Valves shall be of the Double Flanged, Off-Set Disc type to either DIN 3202 F4 or to BS5155. Valve bodies and discs will be Ductile Iron to GGG 50, 300 micron minimum fusion bond epoxy powder coated internally and externally.

The valves shall have SS weld deposited seats, ground and Micro finished.

The seal on the blade shall be an EPDM continuous molded (Not Glued) rubber 'T' section seal clamped between a SS retainer ring of substantial thickness in order to resist deformation.

All SS internal components and internal SS fasteners, where possible shall be 2 pack Epoxy coated after assembly to prevent galvanic action between the SS components and the body/disc.

All coatings shall be pin-hole free.

The external Lever and Counterweight shall be adjustable, where specified the lever and counterweight shall incorporate an optional external hydraulic damper.

All valves shall be supplied with data Books containing full material certification and copies of the relevant test reports

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9.3 Mounting

The check valve and the discharge isolation valve shall be mounted in horizontal pipework.

10. Pipework

10.1 General

Pipework shall comply with Mech 0001. This, inter alia, specifies that the design and manufacture of pipework shall comply with Mech 7001.

Pipework shall be flanged, and the flanges shall comply with BS EN 1092 for the pressure rating.

10.2 Suction Side Pipework

The design of the suction side pipework shall comply with Mech 0001.

10.3 Discharge Side Pipework

Discharge side pipework shall have a pressure rating which is greater than the shut-off pressure of the pump, i.e. the highest pressure that the pump can produce.

10.4 Pipe Couplings

Two mechanical couplings shall be provided on each pump's suction pipework. Two mechanical couplings shall be provided on each pump's discharge pipework.

Each pair of couplings shall be separated by a length of plain ended, straight, stainless steel pipe which shall be coated in order to provide a barrier to galvanic action with other metals.

Coupling restraints shall be provided only where necessary. Couplings shall comply with Mech 7023.

10.5 Pipe Supports

Pipe supports shall comply with Mech 7024.

Pipes shall be properly supported on floor mounted pipe supports. Pipework supports which are anchored to a concrete wall are also acceptable.

Forces from bends, reducers, closed valves, check valves and any other cause shall be calculated and designed for. The Contractor shall design the supports to resist the forces which are present

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during normal operation, during dormant conditions, during testing, during start up and during shut down of each pump individually and for operation of the pump station as a whole.

If the pumps are driven by electric motors, then the forces which will be experienced under electric supply failure shall also be allowed for.

10.6 Drains and Air Release

Manual air release cocks shall be provided on the suction line and on the discharge line.

A manual drain with valve shall be provided on the suction side and on the discharge side.

The socket nipples for such drains and air release cocks shall be of stainless steel, welded into the pipework. The internal pipe corrosion protection system shall completely cover the weld area.

11. Electric Motor Drives for Pumps

Electric motors shall comply with Mech 0001.

The continuously rated output of motors shall exceed the shaft power required at the maximum pump power draw for any of the specified duty points by not less than 20 percent unless the pump motor is started Direct-on-Line and with an open discharge valve. In this latter case, the motor rating shall exceed the maximum pump power draw by not less than 30 %.

Motors shall have ingress protection to at least IP 55.

Motors shall be provided with the manufacturer's highest grade of corrosion protection.

12. Plinth and Base Frame

12.1 General

The Contractor shall confirm that the forces from the pump and driver have been accommodated in the design of the mounting arrangement. The Contractor shall submit the base frame and anchor design to the Engineer for acceptance.

Plinths and base frames shall comply with Mech 0001.

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12.2 Electric Motor Driven Pumps

12.2.1 Plinth

The Contractor shall design the pumpset plinth.

The Contractor shall submit the design calculations to the Engineer for acceptance. The calculations shall confirm that the pumpset's enforcing vibration will cause no damaging resonant condition and that the design is suitable for the ground conditions or foundations, as applicable.

Electric motor driven pumps with ratings of 200 kW and above shall be provided with reinforced concrete plinths which are structurally disconnected from the floor and from other pumpset plinths in order to reduce transfer of vibration from an operating machine to a non-operating machine and to prevent building vibration and noise transmission.

Construction of the plinths and provision of all materials, including the provision of vibration isolating elements required by the design, will be done by others in accordance with the Contractor's design.

12.2.2 Base frames and Soleplates

Base frames for pumpsets up to 1 000 kW shall have both pump and motor mounted on a single base frame which is anchored to a concrete plinth. Separate base frames or stainless steel sole plates may be used for pumpsets above 1 000 kW.

Welding on the base frame shall be continuous all round and without crevices. The base frame shall be designed so that liquids do not pool on it.

Base frames shall be hot-dip galvanised after fabrication. No cutting, welding or any action which damages the zinc surface is allowable after galvanising. If the zinc surface is damaged, the base frame shall be blasted to bare steel and re-galvanized.

The Contractor shall arrange for the Engineer to inspect the base frame after fabrication is complete but before galvanising.

The Contractor shall anchor the base frame to the plinth.

All exposed surfaces of soleplates shall be of a suitable grade of stainless steel.

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13. Instrumentation

13.1 General

Instruments shall be provided to perform all specified control functions.

An hour meter which cannot be reset shall be provided and this shall log the running hours of the motors or engines, as applicable.

Instrumentation shall comply with Mech 0001.

13.2 Pressure Measurement

13.2.1 Gauges

A pressure gauge shall be provided on the suction side of each pump. A pressure gauge shall be provided on the discharge side of each pump. A pressure gauge shall be provided on the discharge manifold. If there is a suction manifold, a pressure gauge shall be provided on it.

Gauges shall suit their expected design pressure range and shall comply with Mech 0001. The gauges shall be provided on pipework in positions of steady, uniform flow.

The discharge gauge shall be provided with a ring manifold incorporating four static pressure tappings in accordance with ISO 9906. Pumpsets with power ratings of 200 kW or greater shall be provided with a similar ring manifold on the suction pipework.

13.2.2 Pressure Transducers

Pressure transducers shall be provided for high and low pressure protection of the pump. These shall be in addition to the specified pressure gauges.

13.3 Flow Measurement

13.3.1 Full Bore Magflow

One magnetic flow meter with both local readout and transmission capability shall be provided on the discharge manifold.

13.3.2 Insertion Magflow

One insertion magnetic flow meter shall be provided in the pipework for each pump.

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The meters shall indicate the individual pump flow but shall be used primarily to ensure that the pumps do not operate at either too high flow or too low flow.

The sensor shall be installed in a position of steady, uniform flow.

13.4 Temperature Measurement

Temperature measurement and protection shall be provided for the pump bearings and for the motor bearings (in applications where pumps are electric motor driven) on both Drive End (DE) and Non-Drive End (NDE). High temperature shall cause the unit to shut down. The Contractor shall note the equilibrium temperature reached after 30 minutes of normal operation and shall also note the ambient temperature. The high level shutdown temperature shall then be calculated as follows:

$T_{\text{shut-down}} = T_{\text{equilibrium}} + (40^{\circ}\text{C} - T_{\text{ambient}}) + 10^{\circ}\text{C}$. An alarm shall be provided at a suitable, lower temperature.

Suitable indication shall be provided for each bearing.

Temperature measurement (Casing Temperature Sensors - PT100) and protection shall be installed on the casing to detect abnormal temperatures within pump casing.

13.5 Vibration Measurement

Vibration measurement and protection shall be provided for the pump bearings and for the motor bearings (in applications where pumps are electric motor driven) on both Drive End (DE) and Non-Drive End (NDE). High vibrations shall cause the unit to shut down. The Contractor shall note the equilibrium vibrations reached after 30 minutes of normal operation. Bearing Vibration Sensors (min. 1 Axis) DE & NDE shall be supplied together with a pump and motors

14. Ventilation

Where the pumpsets are to be installed inside a room, the Contractor shall provide a ventilation system suitable for removing all heat energy transferred into the room by the operating equipment at the duty point when the ambient temperature is 40 degrees Centigrade. The ventilation system shall comply with Mech 1008.

15. Lifting Equipment

The Contractor shall provide an overhead travelling crane in pump stations in which the pumps are

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permanently installed.

The crane shall be motorised, i.e. the long travel, the cross travel and the hoist travel shall all be electrically driven.

The Contractor shall provide the rail beams, the rails, the crane beam and end carriages, the hoist, the cross travel bogey and all associated electrical works.

The gantry supporting the rail beams will be provided by others.

The safe working load for the complete lifting installation shall be at least 1,3 times the heaviest load which has to be lifted.

The crane and installation shall comply with Mech 1003.

16. Materials and Coatings

16.1 General

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Mech 0003. Materials shall comply with Mech 0001.

16.2 Equipment

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Pumps	See Pump clause.	See Pump clause.
Motor	Manufacturer's standard.	Corrosion protection to the high corrosivity category (C4) of SANS 12944-2.

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ITEM	MATERIAL	COATING
Carbon Steel Pipework; wetted surfaces	In accordance with the Contractor's design.	1 000 micron dft, solids containing, epoxy or ester base coating for potable water (solvent free or very low solvent).
Carbon Steel Pipework; non-wetted surfaces	In accordance with the Contractor's design.	250 micron, UV resistant, tenacious, tough coating.

ITEM	MATERIAL	COATING
Stainless Steel Pipework	Duplex stainless steel unless otherwise specified.	Dielectric barrier coating of any type suitable for direct application to stainless steel with a minimum dft of 50 micron (<i>This requirement does not apply to small bore, auxiliary pipework</i>).
Base frame	See Base frame clause.	See Base frame clause.
Pipe Supports	As per Mech 7024.	As per Mech 7024.
Isolation Valves	As per Mech specification.	As per Mech specification.
Check Valves	As per Mech specification.	As per Mech specification.
Double acoustic louvres for inlet and outlet air	Stainless steel.	Pickle and passivate.
	Carbon steel.	Hot dip galvanise.
Weather louvres	Stainless steel.	Pickle and passivate.
	Carbon steel.	Hot dip galvanise.
Mesh screen	EN Grade 1.4401 (316) stainless steel.	Pickle and passivate.

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Anchor fasteners	EN Grade 1.4401 (316) stainless steel.	Not applicable.
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning. Metal plating of ferrous materials is not acceptable as the corrosion protection system. Steel and cast iron items which have been hot dip galvanised, but which are then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.		

17. Fasteners

Fasteners shall comply with Mech 0001.

18. Electrical Equipment

Refer to the electrical specifications.

19. Spares

Contractor shall provide comprehensive list of:

- Commissioning spares – components needed for starting of the pumps only
- 2 years Critical parts/spares – Required in the event of catastrophic pump failure
- 2 years maintenance parts/spares – General maintenance parts

20. Fabrication, Delivery and Installation

20.1 Fabrication

Fabrication and welding shall comply with Mech 0001.

Fabrications will be inspected by the Engineer after fabrication is complete.

20.2 Delivery

When pumps and motors are transported, care shall be taken to prevent damage to bearings.

20.3 Installation

20.3.1 General

Installation work shall comply with Mech 0001.

					
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20.3.2 Maintenance / Access

Installations shall allow reasonable access for all required maintenance activities.

The spacing of adjacent pumps shall provide an open distance between the two units of at least 1 200 mm.

20.3.3 Testing

The installation shall provide for the specified Site testing procedures.

20.3.4 Small Bore Pipework

Auxiliary small bore pipework, including fittings, shall be of stainless steel. Flexible lengths shall be of stainless steel braided hose.

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21. Civil and Building Works

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

22. Safety

The Contractor shall design and install all equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations and, if applicable, in accordance with the requirements for hazardous areas.

Rotating elements shall be fully guarded, and it shall not be possible to insert a hand or finger to come into contact with moving parts.

23. Inspections

23.1 Fabrications

Fabrications such as the base frame, pipe supports, and the lifting equipment will be inspected by the Engineer after fabrication is complete but before corrosion protection. The Contractor shall make all arrangements and carry all costs for these inspections.

23.2 Equipment

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. This report shall confirm compliance of the equipment with the specifications prior to dispatch from the manufacturer's works.

23.3 Pumps

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The pumps shall be inspected at the factory. The impellers and diffusers shall be available for inspection.

23.4 Site

The Contractor shall make arrangements for the Engineer to inspect the installation on Site.

24. Testing

24.1 General

The Contractor shall make all arrangements and carry all costs for witness tests.

Engine driven pumps may be tested using electric motors. Using the actual engine to be provided is, however, preferred.

The Contractor shall submit reports for all specified tests to the Engineer prior to the equipment being transported from the factory to Site and before payment is authorised.

24.2 Pressure Testing

24.2.1 Pumps

The Contractor may test the pump's stage casings either separately or fully assembled, or a combination of the two, on condition that the following requirements are all met:

- The fully assembled pump casings shall be tested to a hydrostatic test pressure of at least 1,5 times the design pressure of the suction casing for a period of thirty minutes.
- The test pressure for each stage shall not be less than the pressure which would be experienced by that stage at the pump's shut-off conditions.
- The test pressure for the final stage shall not be lower than the pump's shut-off pressure.

24.2.2 Valves

The Contractor shall pressure test the valves in compliance with the requirements of the applicable Mech specification.

24.3 Pump Performance Testing at Factory

24.3.1 Pumpsets (< 75 kW)

Pumps smaller than 75 kW shall be performance tested for power demand, flow, head and efficiency at the specified guarantee point.

The test shall be performed in accordance with ISO 9906 and shall comply with Acceptance grade 2B for head, flow and efficiency.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The Contractor shall submit the test report to the Engineer for acceptance. This report shall include confirmation that the specified power margin for the motor or engine has been obtained.

24.3.2 Pumpsets 75 kW - 250 kW

Pumps between 75 kW and 250 kW shall be performance tested for power demand, flow, head and efficiency at the specified guarantee point. The test shall be performed in accordance with ISO 9906 to Acceptance grade 1B for head, flow and efficiency.

The Contractor shall submit the test report to the Engineer for acceptance. This report shall include confirmation that the specified motor or engine power margin has been obtained.

24.3.3 Pumpsets > 250 kW

The Contractor shall make all arrangements and carry all costs for the Engineer to witness the following for pumps with power ratings above 250 kW:

- The casing pressure tests.
- The pump performance testing for power demand, flow, head and efficiency at the specified guarantee point. The pump test shall be performed in accordance with ISO 9906 and shall comply with Acceptance grade 1B for head, flow and efficiency.

The Contractor shall submit the test report to the Engineer for acceptance. This report shall include confirmation that the specified motor or engine power margin has been obtained.

24.4 Pump Performance Testing on Site

24.4.1 All Pumps

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.
- c) control system operation.
- d) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

24.4.2 Pumpsets > 250 kW

Pumpsets of 250 kW and larger shall be performance tested on Site, after installation, for flow, head and efficiency at the specified guarantee point.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The pump test shall be performed in accordance with ISO 9906 and shall comply with Acceptance grade 2B for head, flow and efficiency.

The design of the installation shall accommodate the requirements for this testing.

24.5 Motor Performance Testing

The Contractor shall test and shall submit the motors' factory performance testing report to the Engineer for acceptance.

25. Documentation to be Provided

25.1 Pump Design

Large scale curves for the pump offered shall be provided with the tender offer. These shall include pressure, power and NPSH_r vs flow.

Adequate information shall be provided in the tender to confirm that the specified operating points (whether there will be one operating point or multiple operating points or a range of operating points) are within the pump manufacturer's recommended operating range for the pump.

25.2 Manual

The pump curves and all equipment manufacturer's installation, operation and maintenance manuals shall be provided in the Manual.

The Manual for the pump station shall comply with Mech 0002.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PSE: PARTICULAR SPECIFICATIONS FOR ELECTRICAL
REFURBISHMENT AND UPGRADE WORKS

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.10 PSE- 01: PARTICULAR SPECIFICATION FOR 6.6kV HIGH LIFT PUMP ELECTRIC MOTOR RATED UP TO 2000kW (2682hp)

1. Introduction

This specification shall apply to the purchase including design, manufacturing, factory testing, delivery to site, installation, onsite testing and commissioning of medium voltage squirrel cage induction motors with rated voltage at 6.6kV suitable for driving the centrifugal water pumps for LNW. Training of LNW's operations and maintenance personnel shall also be covered by this specification.

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

2.1 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.

2.2 Work to be Included

- Documentation, as called for in the tenderer QA and document requirement list and drawings and data.
- Recommended spares for one year's operating and price of same.
- Technical assistance if requested during checking for operational readiness
- The medium voltage motors required will be as per the table below:

Water Scheme	Pump Station	Pump	Motor Voltage (kV)	Motor Size (kW)	Motor Cooling	Motor Manufacturer
Olifantspoort	Pump Station 1	Pump 1	6.6kV	1700 kW	Water-cooled	TBA
		Pump 2	6.6kV	1700 kW	Water-cooled	TBA
		Pump 3	6.6kV	1700 kW	Water-cooled	TBA
		Pump 4	6.6kV	1700 kW	Water-cooled	TBA
		Pump 5	6.6kV	1700 kW	Water-cooled	TBA
	Pump Station 2	Pump 1	6.6kV	1700 kW	Water-cooled	TBA
		Pump 2	6.6kV	1700 kW	Water-cooled	TBA
		Pump 3	6.6kV	1700 kW	Water-cooled	TBA

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Water Scheme	Pump Station	Pump	Motor Voltage (kV)	Motor Size (kW)	Motor Cooling	Motor Manufacturer
	Pump Station 3	Pump 1	6.6kV	1700 kW	Water-cooled	TBA
		Pump 2	6.6kV	1700 kW	Water-cooled	TBA
		Pump 3	6.6kV	1700 kW	Water-cooled	TBA
Ebenezer	Pump Station	Pump 1	6.6kV	1100 kW	Water-cooled	TBA
		Pump 2	6.6kV	1100 kW	Water-cooled	TBA
		Pump 3	6.6kV	1100 kW	Water-cooled	TBA
		Pump 4	6.6kV	1100 kW	Water-cooled	TBA

Table 1: Required O & E Water Scheme High Lift Pumps 6.6kV Motors

- v. Training of LNW's operations and maintenance personnel

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.

- OHS Act 85 of 1993 - Occupational Health and Safety Act, Act No. 85 of 1993
- IEC 60034 - Rotating electrical machines
- IEC 60085 - Electrical insulation – Thermal evaluation and designation
- IEC 60751 - Industrial platinum resistance thermometer sensors
- ISO 281 - Rolling bearings – Dynamic load ratings and rating life
- IEC 61800-4 - Adjustable speed electrical power drive systems Part 4: General requirements – Rating specifications of a.c. power drive systems above 1000VAC and not exceeding 35kVAC
- IEC 60076-11 - Power transformer – Part 11: Dry-type transformers
- IEEE 519-2014 - Recommended Practice and Requirements for Harmonic Control in Electric Power System
- IEEE 1100 - Powering and Grounding Sensitive Electronic Equipment
- IEC 61000-4-7 - General Guide on Harmonics and Inter-harmonics Measurement and Instrumentation, for Power Supply Systems and Equipment

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Connected Thereto

- IEC 61000-4-30 - Power Quality Measurements Methods
- IEC 61000-4-15 - Testing and Measurements Techniques– Flickermeter-Functional and Design Specification
- IEEE 1453 - IEEE Recommended Practice – Adoption of IEC 61000-4-15:2010, Electromagnetic compatibility (EMC)-Testing and Measurement Techniques-Flickermeter-Functional and Design Specification
- IEEE C57 - Standard for General Requirements for Dry-Type Distribution and Power Transformer

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
- NRS - National Rationalisation of Specifications
- SANS - South African National Standards
- SAT - Site Acceptance Test
- UPS - Uninterrupted Power Supply
- VFD/VSD - Variable Frequency Drive/Variable Speed Drive
- PMW - Pulse Width Modulation is a method of controlling power devices to covert voltage levels. PWM is a popular method of control for converting DC voltage to AC voltage
- IGBT - Insulated Gate Bipolar Transistor is a high-speed electrical switching power device. It is very efficient requiring very low power for control circuits
- HCT - Hall effect Current Transformer is used for current detection of DC to high frequency without direct contact or shunt
- CPT - Control Power Transformer is typically used to power control circuits and relays for the VSD/VFD

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- LCD - Liquid Crystal Display is a device used for displaying of alpha-numeric or graphical characters
- NPC - Neutral point clamping is a VFD/VSD topology that has the advantage of reducing the high line neutral voltage that can occur in other traditional drive designs that can reach 2.7 to 3.3 times normal levels
- MTBF - Mean Time Between Failures
- MTTR - Mean Time to Repair
- A - Amperage
- V - Voltage
- RTDs - Resistance Temperature Detectors

5. Performance Requirements

5.1 Technical Particulars

- a. Type - High energy efficient squirrel cage induction motor with rated load efficiency as follows:

<u>Rated Output</u>	<u>Minimum Efficiency @ 100% Load</u>
Less than 500 kW	95.0 %
500 kW – 990 kW	95.5 %
1,000 kW and above	96.0%
- b. Standards - IEC 60034, IEC 60072 and other relevant international standards
- c. Duty Rating - Maximum continuous rating (MCR), S1 duty to IEC 60034-1
- d. Insulation - Class F design with temperature rise not exceeding the limit applicable to Class B in IEC 60034-1
- e. Maximum Speed - 1,500 rpm at 50Hz
- f. Noise Level - Mean sound power level (Lw) in dB(A) for airborne noise emitted by motor not exceeding

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

the limits given in IEC 60034-9.

g. Vibration Level	-	Grade A of IEC 60034-14		
h. Uncorrected Power Factor	-	@ 50% Load	@ 75% Load	@ 100% Load
		0.77	0.87	0.89

5.2 Electricity Supply

a. Main supply	-	33 kV, 6.6 kV 3 phase, 50 Hz, 3-wire resistive earthing neutral system
b. Normal limits of voltage fluctuation	-	+10% -2.5 %
c. Normal limits of frequency variation	-	±2%
d. Auxiliary power supply	-	220V ±10% single phase 50 Hz and 24V ±15% d.c.

5.3 Starting Performance

Direct-on-line starting current at rated voltage shall not exceed 5 times the full load current for motors of 500 kW and above, and not exceed 6 times the full load current for motors below 500 kW.

The motor shall be designed to permit at least three starts per hour equally spaced during normal running conditions. The motor shall also be suitable for two starts in succession followed by a 30 minute interval before attempting another starting sequence.

The minimum voltage at motor windings at starting shall be 80% of nominal value for direct-on-line started motor, and 50% for motor with variable frequency/speed starter.

The starting (run-up) torque characteristics of motor at minimum voltage shall be adequate for driving the load to full running speed under the most arduous conditions specified. The accelerating torque at any speed up to the peak torque point shall be not less than 10% of the motor rated full load torque.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Direct-on-line started motor with 80% rated voltage across its winding shall run to 90% of its synchronous speed within 4 seconds. Motor with assisted starting, at 50% rated voltage across its winding and without changing to its final connection, shall run to at least 90% of its synchronous speed within 10 seconds. During such starting intervals, the pump discharge valve shall open in its normal manner.

5.4 Running

Notwithstanding the voltage fluctuation specified in Clause 5.3 above, motors shall be capable of operating continuously at any voltage in the range 90-110% of its rated voltage.

Motors shall be capable of continuous operation at 75% of its rated voltage at 50 Hz for a period of 5 minutes without excessive heating.

5.5 Transient Recovery

Motors shall be capable of recovering normal operation in the event of a system disturbance causing temporary loss of supply voltage for a period of up to 0.2 second (fault clearance time) followed by a sudden restoration to 80% of its rated voltage. At this voltage the motors shall then be capable of accelerating to ultimate recovery under the most arduous load conditions, e.g. fully open pump discharge valve, etc.

5.6 Power Rating

The rated motor power output shall not be less than 120% for freshwater pump set of the maximum power absorbed by the pump over the entire pump operating range specified. The foregoing power margin shall not be reduced by any factors such as tolerances of pump set performance or accuracy of test equipment.

6. Design and Construction

6.1 Enclosure

The enclosure shall have a degree of protection of IP 22 (drip proof) or IP 55 (totally enclosed) to IEC 60034-5. Dimensions and frame number of motors shall comply with IEC 60072. Motors of size less than 1,000kW shall be protected to IP 55.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

3.10.11 PSE - 02: PARTICULAR SPECIFICATION FOR MEDIUM VOLTAGE ADJUSTABLE FREQUENCY/SPEED DRIVES RATED 224 kW (300HP – 7 457kW (10,000HP)

1. Introduction

This specification shall apply to the purchase including design, manufacturing, factory testing, delivery to site, installation, onsite testing and commissioning of adjustable 6.6kV 50Hz VFDs/VSDs configured for MV induction motors installed in LNW's Olifantspoort Water Scheme Pump Stations. Training of LNW's operations and maintenance personnel shall also be covered by this specification.

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

- i) 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.
 - ii) Documentation, as called for in the tenderer QA and document requirement list and drawings and data.
 - iii) Recommended spares for one year's operating and price of same.
 - iv) Technical assistance if requested during checking for operational readiness
 - v) Training of LNW's operations and maintenance personnel
 - vi) Work to be included
- i. Adjustable 2146HP (1700kW), 6.6kV 50Hz VFDs/VSDs configured for MV induction motors to be installed in LNW's Olifantspoort Water Scheme Pump Stations as detailed below

Water Scheme	Pump Station	Pump	Motor Voltage	Motor Size (kW)	Motor Cooling	Motor Manufacturer
Olifantspoort	Pump Station 1	Pump 1	6.6 kV	1700 kW	Water-cooled	TBA
		Pump 2	6.6 kV	1700 kW	Water-cooled	TBA
		Pump 3	6.6 kV	1700 kW	Water-cooled	TBA
		Pump 4	6.6 kV	1700 kW	Water-cooled	TBA
		Pump 5	6.6 kV	1700 kW	Water-cooled	TBA
	Pump	Pump 1	6.6 kV	1700 kW	Water-cooled	TBA

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

	Station 2	Pump 2	6.6kV	1700 kW	Water-cooled	TBA
		Pump 3	6.6kV	1700 kW	Water-cooled	TBA
	Station 3	Pump 1	6.6kV	1700 kW	Water-cooled	TBA
		Pump 2	6.6kV	1700 kW	Water-cooled	TBA
		Pump3	6.6kV	1700 kW	Water-cooled	TBA

Table 1: Olifantspoort Water Scheme High Lift Pumps 6.6kV Motors

Note 1: The VFD/VSDs size will be estimated for 1600kW Motors but will be adjusted to suit the final size motors once the final pump sizes are confirmed. Preliminary pump sizes proposed by Sulzer will require this size of motors.

- ii. The VFD/VSD shall be air-cooled
- iii. The VFD/VSD system must:
 - Represent a fully integrated package. Any components not manufactured by the VFD/VSD manufacturer shall be purchased by the VFD/VSD manufacturer and supplied with the VFD/VSD.
 - Include all material and labour necessary to interconnect any VFD/VSD system element, even if shipped separately
 - Any modification to a standard product provided to meet this specification shall be performed by the VFD/VSD manufacturer only
 - The VFD/VSD system shall be completely factory pre-wired, assembles and then tested as a complete package by the VFD/VSD manufacturer, to ensure properly coordinated, fully integrated drive system
 - Any third- party certification, safety or protection requirements shall be applied to the VFD/VSD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
- iv. The following equipment shall be furnished and installed as indicated
 - Main power supply to VFD/VSD from existing 6.6kV Switchgear shall be installed by the Contractor
 - Main power supply from VFD/VSD to 6.6kV High Lift Pump Motors shall installed by the Contractor
 - All external control cabling shall be installed by the Contractor
 - Internal auxiliary and control power supplies shall be derived as specified in the VFD/VSD by the Manufacturer
 - If the Manufacturer cannot meet this requirement due to specific drive design, Manufacturer shall explicitly provide this requirement

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

to the installing Contractor at time of equipment bid and details for external supply requirements shall be provided and included in the submittal documents.

- Supervision of installation and commissioning of VSD/VFD

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.

- OHS Act 85 of 1993 - Occupational Health and Safety Act, Act No. 85 of 1993
- SANS1874:2015 / NRS 006:2013 - Switchgear-Metal-enclosed
- IEC 60076 - Power Transformers
- IEC 61131-3 - Programmable Controllers Part 3: Programming languages
- IEC 61800-3 - Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods
- IEC 61800-4 - Adjustable speed electrical power drive systems Part 4: General requirements – Rating specifications of a.c. power drive systems above 1000VAC and not exceeding 35kVAC
- IEC 60076-11 - Power transformer – Part 11: Dry-type transformers
- IEEE 519-2014 - Recommended Practice and Requirements for Harmonic Control in Electric Power System
- IEEE 1100 - Powering and Grounding Sensitive Electronic Equipment
- IEC 61000-4-7 - General Guide on Harmonics and Interharmonics Measurement and Instrumentation, for Power Supply Systems and Equipment Connected Thereto
- IEC 61000-4-30 - Power Quality Measurements Methods
- IEC 61000-4-15 - Testing and Measurements Techniques– Flickermeter-Functional and Design Specification
- IEEE 1453 - IEEE Recommended Practice Practice – Adoption of IEC 61000-4-15:2010, Electromagnetic compatibility (EMC)-Testing and Measurement Techniques-Flickermeter-Functional and Design Specification

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- IEEE C57 - Standard for General Requirements for Dry-Type Distribution and Power Transformer

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
- 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
- CPU - Central Processing Unit
- DI - Digital Input
- DO - Digital Output
- AI - Analog Input
- AO - Analog Output
- FBD - Functional Block Diagram
- FAT - Factory Acceptance Test
- FDS - Functional Design Specification
- HMI - Human Machine Interface
- I/O - Input/Output
- PLC - Programmable Logic Controller
- SCADA - Supervisory Control and Data Acquisition

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- SAT - Site Acceptance Test
- UPS - Uninterrupted Power Supply
- VFD/VSD - Variable Frequency Drive/Variable Speed Drive
- PMW - Pulse Width Modulation is a method of controlling power devices to covert voltage levels. PWM is a popular method of control for converting DC voltage to AC voltage
- IGBT - Insulated Gate Bipolar Transistor is a high-speed electrical switching power device. It is very efficient requiring very low power for control circuits
- HCT - Hall effect Current Transformer is used for current detection of DC to high frequency without direct contact or shunt
- CPT - Control Power Transformer is typically used to power control circuits and relays for the VSD/VFD
- LCD - Liquid Crystal Display is a device used for displaying of alpha-numeric or graphical characters
- NPC - Neutral point clamping is a VFD/VSD topology that has the advantage of reducing the high line neutral voltage that can occur in other traditional drive designs that can reach 2.7 to 3.3 times normal levels
- MTBF - Mean Time Between Failures
- MTTR - Mean Time to Repair
- A - Amperage
- V - Voltage
- RTDs - Resistance Temperature Detectors

5. System Description

5.1 VSD/VFD Components

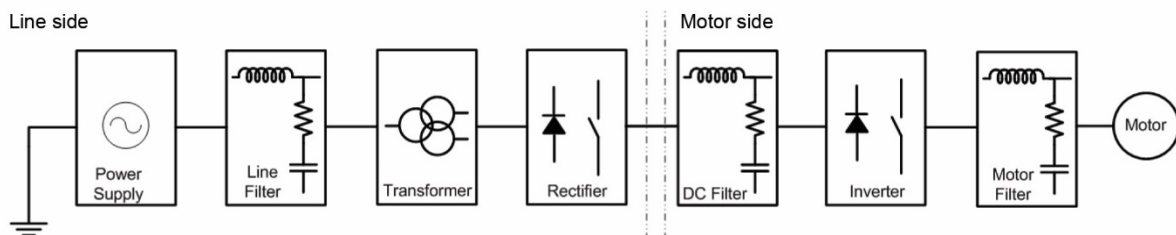


Fig 1: VSD/VFD Functional Block Diagram

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

a. Line Side

- Main Incoming Power Supply
 - Nominal Voltage: 6600V (6.6kV), 3-phase, 50Hz. A single main feed will be provided for each VFD/VSD
 - Maximum fault level: 25kA
- Existing metal Clad Switchgear
 - System input protection
 - Electrically interlocked with VFD/VSD
 - Existing Metal clad switchgear with vacuum Circuit breaker to be used with basic open/close/trip signals and feedback
- Line Filter (if required)
- Phase Shift Transformer
 - Provide manufacturer's standard multi-pulse phase shifting transformer (24-pulse minimum)
 - Transformer shall be installed integrally to the drive enclosure. Include all fuses, cabling, and vibration dampening required
 - Transformer shall be dry-type, be K-rated for use with high harmonic power systems, and include electrostatic shielding between the windings
- Rectifier Section
 - Diode bridge with required protection

b. Motor Side

- DC Bus/Filter Section
 - Capacitors
 - Long-life film-type capacitors shall be preferred
 - Electrolytic capacitor designs will be considered. Storage and maintenance requirements related to the capacitor shall be explicitly stated in the submittal documents
 - Designs incorporating pre-charge circuits for limiting transformer inrush and peak diode current shall be preferred
 - Drive input contactor operating restrictions (operations per day, control/interlock requirements) shall be explicitly stated in the submittal documents
- Inverter Section
 - Modular multi-level converter or modular cascaded H-bridge topology with PWM operation producing a "motor-friendly"

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- waveform for cable runs up to 1000m without additional filtering shall be preferred,
 - NPC designs will be considered. NPC designs shall be provided with output filters shall be included in efficiency and MTBF/MTTR calculations
 - Output waveforms shall result in torque pulsations less than 1%
- Forced Air Cooling System
 - Discharge to room
 - Integral CPT shall be supplied within the drive enclosure for the derived 400V, 50Hz supply and shall be sized as required for fan systems
 - If an external 400V supply is required by the supplied VFD/VSD manufacturer, it shall be explicitly stated in the submittal documents

5.2 Performance Requirements

b. General

- Nothing in this standard shall lessen the obligation of the Manufacturer and/or Contractor. The Manufacturer and/or Contractor shall be fully responsible and liable for the design, manufacturing testing at works, delivery to site, installation, onsite testing and its satisfactory performance in service. Approval by SMMMS and LNW shall not relieve the Manufacturer/Contractor of the responsibility for the safety, operability and maintainability of the VFD/VSD.

c. Service Conditions

The requirements in this specification apply to transformer for use under the following general condition in Table 1.

Environment	Limits
Application	Indoors
Altitude	The design shall be based on an altitude of 1800m a.m.s.l
Maximum ambient air temperature	Hottest anytime 40°C Hottest monthly average 30°C
Yearly average ambient air temperature	20°C
Minimum ambient air	Coldest anytime -10°C



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

temperature	
Variation in humidity	10% to 90%

Table 2: Atmospheric condition

a. Performance

i. General

- The VFD/VSD shall have a sensor-less vector torque control algorithm with static speed error of less than 0.5% without the use of a tachometer or encoder
- Drive system shall achieve a desired output frequency (set point) with a repeatability of 0.1% of rated frequency of 60 Hz.
- The VFD/VSD shall provide an automatic current limit feature to control motor currents during start-up and provide a “soft start” torque profile for the motor-load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD/VSD output current, and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
- The VFD/VSD shall be capable of 100% rated current in continuous operation.
- The VFD/VSD one-minute overload current rating shall be 110% of the rated current for variable torque applications.
- The VFD/VSD shall be capable of providing rated output from 0% speed to operating speed at continuous voltage deviation of +10% and -5%
- The VFD/VSD shall be able to ride through voltage dips down to 70% of nominal, such as those experienced during motor starting.
- The VFD/VSD system shall be capable of continuous operation in the event of a power loss of 5 cycles or less.
- The VFD/VSD shall be able to return to normal operation following an incoming power disturbance that falls within the range determined by Figure 3-2 in IEEE 1100.
- The VFD/VSD shall be able to catch and take control of a spinning load if started while rotating equipment is already spinning. Appropriate safeguards shall be included in this operation to prevent damaging torques, voltages or currents from impacting any of the equipment. The user shall be able to selectively apply this feature.
- The VFD shall be capable of producing a variable voltage/frequency output to provide continuous operation over the speed range of 0 to 100%. The VFD/VSD must be capable of sustained operation at 10% speed to facilitate checkout and maintenance of driven equipment. As a commissioning and troubleshooting feature, the VFD/VSD power circuit shall be capable of operating without motor connected to the VFD/VSD output.



Contractor



Witness 1



Witness 2



Employer



Witness 1



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ii. **Safety**

- The safety of the operating, maintenance and service personnel is to be considered as the most important design criteria.
- The enclosure doors (except giving access to LV compartments) shall be interlocked such that the main incoming power supply must be earthed prior to opening. Methods of access control shall be coordinated with the drive input contactor. Method includes:
 - Safety earth switch installed within the VFD/VSD. Switches shall not be operable while power is applied to the drive (make-proof)
 - Safety earth switch installed on the load side of the drive input contactor with key or electrical interlocks
- HV equipment shall be installed in separate compartments from LV equipment with earthed barriers in between.
- DC Bus capacitors shall discharge when mains power is removed. Indication shall be provided to the Operator that the DC Bus is charged/recharged.
- If flammable liquids are required (e.g. oil-filled capacitors), the manufacturer shall clearly define the quantities of flammable liquid required and the heat content.

iii. **Reliability**

- Importance shall be given for trouble free operation, reliability, and availability of the equipment.
- The manufacturer shall list any control or power components that require recommended maintenance or replacement before 40,000 hours of operation. Information must be available in manufacturer's maintenance manual and available for submittal.
- The calculated availability of the VFD shall be greater than 99.95% and shall be calculated based on the expected down time due to corrective and preventive maintenance. If required to meet the limit, include automatic cell bypass, N+1 cell redundancy, or similar.
- The VFD design must demonstrate an actual mean time to repair of less than 24 hours, in the event of any power switching component failure.

iv. **Efficiency**

- Guaranteed minimum total VFD/VSD system efficiency shall be a minimum 95.0% at 100% speed and 100% load
- Efficiency evaluation shall include the drive isolation transformer, VFD/VSD

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converter, output filter (if provided), as specified below. Auxiliary controls, such as internal VFD/VSD control boards, cooling fans or pumps, shall be included in all loss calculations.

v. **Input Power Quality**

- The VFD/VSD shall comply with the latest revision of IEEE 519 for total harmonic current and voltage distortion measurements and calculation. Voltage distortion shall not exceed 3% and current distortion shall not exceed 5% while operating for the utility line. Individual current harmonics shall not exceed the requirement of IEEE 519.
- Actual distortion will be measured when the equipment is installed and energized. If distortion exceeds the specified limits, the equipment manufacturer shall be responsible for reducing distortion to within these limits at no expense to the Purchaser.
- The total power factor at the VFD/VSD shall not be less than 0.97 for the load range of 20 to 100%. The VFD/VSD, including power factor correction and/or harmonic filter, shall never have a leading power factor.
- The transformer/rectifier shall be designed to eliminate the need for harmonic filters. Harmonic filters are undesirable and subject to approval by the LNW.

vi. **Motor Compatibility**

- Motor life expectancy shall not be compromised in any way by operation with the VFD/VSD system.
- The VFD/VSD shall provide motor overload protection in all operating condition.
- VFD/VSD output current waveform, as measured at the motor, shall be inherently sinusoidal at all speeds with a total harmonic current distortion not exceeding 3% of the motor rated current between +10% to +100% speed regardless of loading.
- VFD/VSD utilizing output transformer are not acceptable.
- The system design shall not have any inherent output harmonic resonance in the operating speed range.
- VFD/VSD output shall produce electrically induced pulsating torque to the output shaft of the mechanical system of less than 2%
- VFD/VSD shall inherently protect motor from high voltage dv/dt stress, independent of cable length to the motor. VFD/VSD shall not require nonstandard insulation system or insulation ratings above the VFD/VSD output voltage rating. The VFD/VSD system shall be designed to produce no standing waves or overvoltage conditions based on a cable length of at least 1000m. If the VFD/VSD requires an



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output filter to meet this requirement, it shall be an integral part of the VFD/VSD system and included within the VFD enclosure.

vii. **Protection Functions**

- An Emergency-stop (E-stop) shall be provided on the VFD/VSD door
- Each VFD/VSD shall include input phase loss protection
- The following protection functions shall be available
 - Motor winding or motor phase to phase short circuit
 - Motor earth fault protection
 - Motor phase loss protection
 - Motor current unbalance
 - Motor temperature
 - Motor overcurrent
 - Motor overvoltage
 - Motor overload and underload
 - Motor overspeed
 - Motor over-torque
 - Phase to phase and earth faults on the secondary of the drive isolation transformer
 - VFD/VSD cabinet and input transformer overtemperature

viii. **Metering**

- The VFD/VSD shall be capable of continuously monitoring and displaying output power quality. The power quality data shall include the following
 - Motor voltage (rms)
 - Motor current (rms)
 - Motor speed (in rpm or %)
 - Drive output power (kW)

ix. **Controls**

- Each VFD/VSD shall include the following basic operation adjustment
 - Acceleration time
 - Deceleration time
 - Current limit
 - Minimum frequency or speed
 - Maximum frequency or speed
 - Selectable skip frequencies
 - Sensor-less vector parameter settings



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- Local/Off/Remote selection
- Each VFD/VSD shall be equipped with front mounted operator control panel consisting of colour touchscreen with the following functions
 - Local Run/Stop command
 - Local/Remote selection
 - Increase/Decrease speed function
 - Display and adjustment drive parameters
 - Display and reset drive faults/alarms
 - Display actual drive parameters (e.g. actual speed, actual current, etc.)
- Parameters names, fault/alarm messages and other information shall be displayed in plain text to allow the user to understand what is being displayed. The language on panel shall be English
- Graphical representation of the plant
- Switches and Lamps
 - Selector switches, pushbuttons and pilot lamps shall be heavy duty 30mm units rated suitably for the specified enclosure
 - As a minimum the following devices shall be provided
 - Local/Off/Remote selector switch
 - Start and Stop pushbuttons
 -  RED pushbutton shall be for “Start”
 -  GREEN pushbutton shall be for “Stop”
 - Emergency Stop pushbutton
 - Equipment On and Off indicating lamps
 -  RED lamp shall indicate “Equipment On”
 -  GREEN lamp shall indicate “Equipment Off”
 -  AMBER/WHITE lamp shall indicate “Equipment Tripped/Faulty”
 - Speed Potentiometer
- Hardwired inputs and outputs shall be provided to interface with the instrumentation and controls indicated
 - Analog inputs/outputs: 4-20mA, 24Vdc
 - Digital inputs: 24Vdc
 - Digital outputs: Dry contacts rated for 3A at 230Vac and 1A at 24Vdc
 - Alarm outputs shall be open during normal operation and close to alarm
 - RTD inputs: The VFD/VSD controller shall have input provisions for six (6) winding RTDs, two (2) motor bearing RTDs and two (2) pump bearings RTDs.



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RTDs will be PT-100. If the VFD/VSD controller is not capable of direct RTD inputs, a supplemental protection relay or expansion module shall be provided for RTD interfaces.

- The RTD module shall integrate with the VFD/VSD communication protocol (such Profibus DP, Modbus RTU/TCP, Ethernet TCP/IP or any communication protocol that meet the requirement of IEC 61850) such that associated thermal alarms can be monitored through the plant control system network as specified in Communication and Protocols this Section.
- The isolation transformer and cooling system shall have as a minimum the following hardwired signals.
 - Drive isolation transformer overtemperature
 - Cooling system failure
 - Cooling system motor status
- The VFD/VSD common alarm contact shall be open during normal operation and shall close for the following fault conditions
 - Control Power Loss
 - VFD/VSD Failure
 - DC Bus Overvoltage or Undervoltage
 - Open Cabinet Door
 - Motor Overtemperature
 - Motor Overspeed
 - Data Network Failure
 - Drive Isolation Transformer Overtemperature
 - Cooling System Failure
- Provide inputs and outputs as required for the control scheme. Include the following spare I/O's
 - Two (2) analog inputs
 - Two (2) analog outputs
 - Two (2) digital inputs
 - Two (2) digital outputs

x. **Communication and Protocols**

- The VFD/VSD shall be capable of direct communication to a standard computer for setup of parameters, fault diagnostics, trending and diagnostics log downloading
- The VFD/VSD shall be provided with a either Profibus/Modbus/Ethernet communication card capable of communicating on either Profibus DP/ Modbus RTU/TCP, Ethernet TCP/IP network



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- All control functions including start/stop and speed control shall be available via the network
- All status and monitored input points shall be available via the network
- Provide a complete list of available control and indication points including required documentation for network configuration

xi. **Motor Space Heater Power Supply**

- Shall be sourced from the 230V control power supply. 230V CPT shall be sized as required to accommodate the supplied motor space heater.
- The motor space heater power supply will be de-energized when the motor is running.

5.3 Construction

- a. Indoor enclosures shall be IEC 60529 with gaskets and filters
- b. Enclosures shall be designed for bottom cable entry
- c. The cubicle design and painting procedure shall guarantee effective electromagnetic compatibility
- d. The enclosure must be designed to avoid harmonic and inductive heating and eliminate radio frequency interference.
- e. Noise level at 1m distance shall be less than 85 dB for a single air cooled VFD/VSD.
- f. Control boards shall be conformally coated and shall be consistent for all power ratings.
- g. Control circuitry shall be galvanically separate from power circuitry using fibre optics or similar methods
- h. Cable Terminations
 - A separate terminal compartment shall be provided for cable terminations with separate access from VFD/VSD components
 - Power terminal cabinet shall be sufficient size to permit proper termination of medium voltage shielded power cables with stress relief devices
 - Provide a copper earth pad in each terminal cabinet for termination of earth wires
 - Provide means of supporting cables so that they will not place excessive loads on the bushings.
 - Provide lug oriented such that cables entering from the bottom cab be properly installed

2. DRIVE ISOLATION TRANSFORMER

6.1 General



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- A drive isolation transformer shall be furnished to provide power conversion from the line voltage to the required VFD/VSD voltage and reduce harmonics seen on the line and isolate the from common mode voltage. The transformer shall conform to IEEE C57.
- The transformer shall be an integral part of the VFD/VSD enclosure.
- The current carrying capability of each transformer shall be limited by the capacity of the core and coils, not by the capacity of the other current carrying components such as bushings and tap changers.
- Transformer temperature limits shall be as specified in IEEE C57.134.
- The transformer shall be designed to withstand a short circuit. It shall maintain electromagnetic symmetry when only one secondary winding is in short circuit to minimize the resulting short circuit forces. The transformer shall be capable of thermally withstanding a short circuit for 2 seconds.
- Transformer shall be of high efficiency type with full load losses of less than 3%.
- The transformer shall include a temperature monitoring device with alarm contacts.
- The transformer shall be of Temperature Class 220°C and average winding temperature rise by resistance of 115°C (above 40°C ambient).

6.2 Ratings

- The manufacturer shall determine the transformer kVA rating, impedance, winding configuration, and voltage rating of the low voltage winding as required for proper operation of the VFD/VSD system.
- Provide current and voltage transformers as required for the specified metering and protection functions. Voltage transformers, if required, shall be provided in a 3-phase wye configuration.

6.3 Construction

- Core laminations to be “nonaging” cold-rolled, grain-oriented, highly permeable, silicon alloy steel. Assembled core shall be treated with heat-resistant resin for high resistance to moisture and contaminations.
- Vibration dampers between base and core-coil assembly
- Porcelain or cast epoxy supports and spacers for coils, leads, terminals and other live parts.

6. Output Filter (if Required)

7.1 Shall allow output cable runs up to 1000m as specified

7.2 Shall be designed to eliminate reflective waves and convert the PWM

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wave form to a near sinusoidal wave form

7.3 Shall increase the dv/dt by a factor of at least 20

7.4 Shall reduce torque pulsation to less than 2% and shall eliminate voltage wave reflections

7.5 Shall be designed for use with a wide range of carrier frequencies to coordinate with the drive's carrier frequency range and fundamental frequencies from 0 to 50Hz.

7.6 Shall limit voltage distortion to less than 5%

7.7 Insulation shall be Class R (200°C) with temperature rise of 115°C

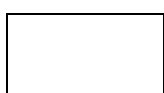
7. Execution

7.1 Installation

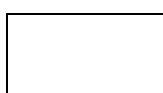
- Installation to conform to manufacturer's instruction.
- Completely install as specified, indicated, or required for operation and continuous service at the locations indicated in the tender document.
- Provide all openings in floor, walls, roofs and other structures necessary for complete equipment installation, unless such openings are specially indicated as being provided by others.
- Seal with approved sealant of all holes in concrete walls, floors slabs after installation and all unused holes as approved by the Engineer.
- Level, shim, and anchor to floor or wall with bolts or concrete anchors. Grout all floor mounted equipment.
- Install all necessary wiring/cabling or interconnections as required.
- Make all internal and external connections as indicated and as required by manufacturer's wiring diagrams
- Check all internal and external connections tightness as required.

7.2 Quality Control

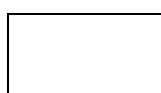
- Prior to By Manufacturer
 - The VFD/VSD manufacturer shall provide all required specialized technically skilled personnel to supervise/inspect installation, test and start-up all equipment provided.
 - Assist in the setup, configuration, and testing of the VSD/VFD, High Lift Pumps and Motors and the communications network/SCADA system.
- Field Testing and Commissioning
 - Perform "start-up" tests as recommended by the manufacturer



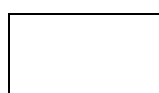
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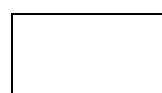
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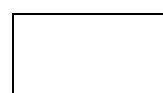
Witness 2



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Witness 1



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- Establish proper direction of rotation for the motor controlled by the VFD/VSD
- Verify that the VFD/VSD operates in the “manual” control mode and in the “automatic” or “remote” control mode.
- Verify that the VFD/VSD's speed adjusts properly with “local” speed controls and “automatic” or “remote” speed signals.
- Set the maximum “locked rotor” current draw as recommended by the manufacturer and approved by the Engineer.
- Adjust the switchgear feeder protection relay settings as recommended by the VFD/VSD manufacturer.
- Set the minimum and maximum speed set points and the acceleration and deceleration ramp time as indicated or recommended by the manufacturer and approved by the Engineer.
- Operate the VFD/VSD at 100% speed for at least 10 minutes and monitor output current. The output current should remain below the full load current listed on the motor nameplate. Check for excessive heating of the VFD/VSD and motor. Report any discrepancies to the Engineer.
- Test network communication and verify that VFD/VSD is responding to commands and reporting statuses properly to the SCADA system.
- Finishes, Adjusting and Cleaning
 - Equipment coatings shall be free from scratches, rust or other defects.
 - All damaged or defective coatings shall be repaired prior to final acceptance
 - Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
 - Field painting shall be performed based on manufacturer's recommended procedures
 - After field installation and final wiring terminations are completed the field connected power and control cabling/wiring shall be adjusted and neatly.
 - final acceptance the VFD/VSD shall be cleaned and free from dust and debris.
- Training
 - Manufacturer shall provide training to LNW's Technical Personnel and SMMMS Engineers on the testing and commissioning of the VFD/VSD
 - Manufacturer shall provide training to LNW's Operations and Maintenance personnel on the operations and maintenance of the VFD/VSD which shall include
 - The training session shall include classroom discussion on the theory of operation and maintenance of the equipment including service methods. Topic to be covered shall include safety, hardware layout and functions, power and control cabling/wiring, diagnostic indicators, HMI keypad/display,

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faults, diagnostic tools, troubleshooting and preventative maintenance

- Hands-on training shall be provided on the VFD/VSD.
- Training manuals shall be provided and shall include manuals and drawings/schematics for the VFD/VSD in hard copies and 1 soft copy

8. 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.

9. 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

10. 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 be specifically required to conduct a performance test on site. A minimum guarantee period of 12 months is required.

3. 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.



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ANNEXURE A:

PART 1: DATA SHEET FOR MV VARIABLE FREQUENCY/SPEED DRIVES (BUYER'S REQUIREMENTS)

Basic Requirement	
Torque requirement	As per attached motor data sheet and speed-torque curve
Load/driven equipment	Centrifugal pumps details
Load torque details	Centrifugal pump as per attached data sheet and speed-torque curve
Drive system	1 Drive for 1 pump
Reacceleration of motor	As per Operational requirements
Motor to be used for drive	Estimated size of motors is 1500kW (see Note 1 above). Drives are adjustable.
Input Power Supply System Condition	
No. of phases	Three
AC Input voltage	6.6 kV
Voltage fluctuations	+10% and -5%
Voltage unbalance	±15%
Rated frequency	50Hz
Frequency fluctuations	±5%
System fault level	25 kA (1 sec.)
System Requirements (Vendor shall furnish a separate datasheet for Variable Speed frequency system offered)	
Speed range required	10% – 100%
Speed reference signal	4 – 20mA / 0 – 10V
Operation in case of loss of	Last speed reference / A set speed reference signal lower than previous reference / either of the above as per manufacturer's standard
Acceleration time	During detailed engineering
Deceleration time	During detailed engineering
Communication facility	Required, integration with existing SCADA and PLC between Owner's control system and drive
Harmonic study	Required
Braking	Flux braking / DC injection braking / Either of the above
Converter transformer	Panel mounted Dry type
Output voltage of VFD / VSD	6.6kV, Three-phase, Load / VFD/VSD side system in. 11 level (phase to neutral) PWM true sine

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	wave output
Power factor improvement	Vendor shall ensure that converter design is such that minimum power factor at point of VFD/VSD is 0.97 regardless of speed and load
Efficiency at nominal power	>95.0% at 100% kVA load
Output surge arrestor	Required
Temperature measurement	Required for power cell cubicle
Synchronous bypass	Not mandatory
Dry type Transformer	
HT surge arrestor	Distribution class arrestor on transformer primary side to protect for HT surge
Short circuit protection	Short Circuit Protection for transformer secondary windings
Temperature measurement	Transformer winding temperature measurement & excessive heat loss measurement
Overload protection	Transformer overload protection
Impulse voltage withstand	Type test as per IEC 60076-11 to be performed
Heat run test	To be performed for 8 hours at rated capacity
Shielded isolation	Required between HV and LV winding
Control Locations	
Auto / Manual operation	Required
Auto / Manual selector	At panel / at remote process control panel switch location
Local / Remote operation	Required for controls
Local / Remote selector	At panel / at remote process location control panel switch
Speed Raise / Lower signal	At VFD/VSD panel / At remote control room / At local control station
Separate reset button for alarm and fault	Specific requirement
Torsional Analysis	Required
Distance of Converter Panel From Drive Motor	Up to 1000m
On Communication Network (Compatible Modbus – TCP/IP Network Protocol) the following Details Shall be Available	
Protection features	Yes
Indication	Yes
Metering	Yes
Diagnostic	Yes (Local, Remote: on TCP/IP)
Panel Enclosure	IP42, Min Thickness 2.0mm

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Witness 2

Tender Number: _____

Tender's Authorised Signatory: _____
Name in block letters Signature

Full Name of Tendering Company:

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Witness 1

Witness 2

C3.10.12 PSE- 03: PARTICULAR SPECIFICATION FOR ONSITE MAINTENANCE AND REFURBISHMENT OF MV SWITCHGEAR AND ASSOCIATED EQUIPMENT

1. Introduction

This standard applies to all outdoor and indoor MV electrical switchgear and associated equipment that are currently in use in the LNW's Olifantspoort water scheme pump stations that have been earmarked for testing, maintenance and repairs/refurbishment to extend their operating life for re-use in their network.

An effective switchgear maintenance program is a preventive and corrective maintenance schedule that begins with reviewing the switchgear's service history if available. This review may reveal on-going problems that are both integral to the switchgear and its associated equipment. LNW operates both indoor and outdoor MV switchgear in their pump stations ranging from 6.6kV (indoor metal-clad) to 33kV (outdoor SF₆)

The standard provides guidelines to the Contractors and LNW representatives in determining the degree of the maintenance, repairs and refurbishment/replacement and assists in outlining their responsibilities for the MV switchgear for use by LNW.

2. Scope

This standard covers the general requirements for the maintenance, repairs and refurbishment of 6.6kV Indoor Metal-clad Switchgear for use by LNW. It provides all essential scope information for safe maintenance, cleaning, inspections, testing and replacement/refurbishment tasks that are necessary to ensure the proper operation of electric motors and associated equipment.

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.

- OHS Act 85 of 1993 - Occupational Health and Safety Act, Act No. 85 of 1993
- NRS 003 / SANS 1885 - A.C. metal enclosed switchgear and control gear for rated voltage above 1kV and up to and including 36kV
- SANS 60298 - A.C. metal enclosed switchgear and control gear for rated voltage above 1kV and up to and including 52kV
- SANS 60 - High voltage test techniques
- SANS 60 - High voltage alternating current circuit breakers

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- SANS 10142 - Code of Practice for Wiring of Premises
- SANS 135 - ISO metric black bolts, screws and nuts (hexagon and square)
- IEC 265 / BS 5463 - Air and Oil Switches
- SANS 152 - Low-voltage air-break switches, disconnector and fuse-combination units
- SANS 1195 / BS 159 - Busbar and busbar connections
- IEC 233 / BS 1371 - Bushings
- BS 542 / BS 2562 - Cable glands and sealing boxes
- SANS 156 / BS 4752 - Circuit Breakers
- SANS 1092 - Contactors
- IEC 185 / BS 3938 - Current Transformers
- SANS 60186 / IEC 60186 / BS 3941 - Voltage Transformers
- SANS 172 / SANS 173 / BS 2692 - HV Fuses
- SANS 172 / SANS 173 / IEC 260-1 / BS 88 - LV Fuses
- BS 5227 - Electrical Power Switchgear

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
- OWS - Olifantspoort Water Scheme
- ORHVS - Operating Regulations for High Voltage Systems
- 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
- IR - Insulation Resistance



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Witness 1



Witness 2



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Witness 1



Witness 2

- AC - Alternating Current
- CB - Circuit Breaker
- DC - Direct Current
- GA - General Arrangement
- IR - Insulation Resistance
- PI - Polarisation Index
- CT - Current Transformer
- VT - Voltage Transformer
- MV - Medium Voltage (in this instead refers to 6.6kV)
- kV - kilo Voltage
- kW - kilo Watt (Real/Active Power)
- kVar - kilo Voltage-Amper Reactive (Reactive Power)
- kWh - kilo Watt-hour (Real/Active Energy)
- kVarh - kilo Voltage-Amper Reactive-hour (Reactive Energy)

5. Requirements

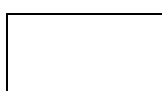
5.1 General

Nothing in this standard shall lessen the obligation of the contractor. The contractor shall be fully responsible for the testing, maintenance and repairs/refurbishment of outdoor and indoor MV switchgear and associated equipment and to ensure its satisfactory safety and performance in service. Approval by LNW shall not relieve the contractor of the responsibility for the adequacy of the maintenance, repairs and refurbishment.

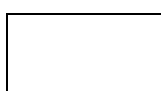
5.2 Service Conditions

The requirements in this specification apply to transformer for use under the following general condition in Table 1.

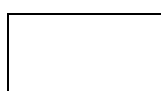
Environment	Limits
Application	Outdoors and Indoors
Altitude	The design shall be based on an altitude of 1800m a.m.s.l
Maximum ambient air temperature	Hottest anytime 40°C Hottest monthly average 30°C
Yearly average ambient air temperature	20°C
Minimum ambient air temperature	Coldest anytime -10°C
Variation in humidity	10% to 90%



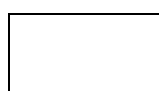
Contractor



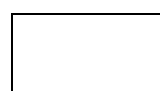
Witness 1



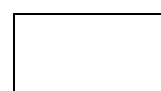
Witness 2



Employer



Witness 1



Witness 2

Table 1: Atmospheric condition

5.3 On Site MV Electric Motor Testing, Maintenance and / or Refurbishment

5.3.1 Site Establishment

This shall include staff induction, processing equipment, establishment of adequate electricity supplies, etc. The site establishment shall be a clean and dry environment with temporary structures as required. The contractor shall bring his own testing equipment LNW shall ensure an area for site establishment; the contractor shall be responsible for the soil preparation and rehabilitation of the soil and site area.

If required, all rigging work shall only be undertaken by a qualified trade tested and certified rigger as per SAQA regulations.

The contractor shall ensure the site is safe and necessary barricading installed when working in a live yard, ensuring both safe working conditions for the contractor and the team members while also ensuring that normal LNW operations can continue. The contractor must have a suitable site agent/supervisor with ORHVS certification present on site at all times during work operations on site.

LNW shall make available 400V for welding and testing purposes but is the responsibility of the Contractor to supply and connect all required cabling and accessories and will also issue Electrical COC for the temporary connections.

5.3.2 MV Switchgear and Associated Equipment

The contractor shall be responsible to supply, delivery and install all equipment and material required to execute the work, even though not specifically referred to in this specification and shall ensure that all the necessary field test facilities and equipment required for the successful execution of the onsite testing, maintenance and repairs/refurbishment are available and in working condition at all times. Only after electrical tests have been conducted and test certificates issued can the switchgear and associated equipment be handed over to LNW.

The allowable work to be done on site shall include:

5.3.2.1 Visual Checks (off-line)

The following are the standard Visual checks requirements:

- Check nameplate information for correctness.
- Inspect enclosures for proper alignment, foundation fixing earthing.
- Inspect all covers, panels section and doors for paint work and proper fit.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Check for smooth and proper movement of racking mechanism for alignment, shutters, roller, rails and guides.
- Check for proper alignment of the breaker primary and secondary contacts
- Check operations of all mechanical interlocks
- Check tightness of all bolted connections (torque wrench method)
- Check bus and supports for defects such as cracked welds, chipped porcelain, cracked insulation, etc. and free of dust accumulation
- Verify all front panel mounted devices (meters, push buttons, switches, indicator lamps, mimic buses, etc.) are installed as per drawings
- Perform mechanical check and visual inspection on all circuit breakers
- Perform mechanical check and visual inspection on all current transformers
 - Inspect for physical damage/defects
 - Check nameplate information for correctness
 - Check that all earthing cables are securely connected
 - Check colour coded for secondary wiring and size against specs
 - Check proper lugs has been used in termination
 - Check CT's location physically and secondary terminal labelling printed
- Perform mechanical check and visual inspection on all voltage transformers
 - Inspect for physical damage/defects
 - Check nameplate information for correctness
 - Check that all earthing cables are securely connected
 - Check colour coded for secondary wiring and size against specs
 - Check proper lugs has been used in termination
 - Check VT's location physically and secondary terminal labelling printed
- Perform mechanical check and visual inspection on all disconnected and earthing switches
- Perform mechanical check and visual inspection on all circuit breakers
 - Check nameplate information for correctness
 - Check tightness of all bolted connections (torque wrench method)
 - Check quality of paintwork
 - Check that all earthing cables are securely connected
 - Check colour coded for secondary wiring and size against specs
 - Check proper lugs has been used in termination
 - Check for correct breaker position indication (breaker open/closed)
 - Check for correct spring status indication (spring charged/discharged)
 - Perform all specific checks on the breaker and spring operating mechanism
- Check that all control wiring is corrected according to the specification to the approved

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

drawing and terminal connections are secure

5.3.2.2 Test Procedure

5.3.2.2.1 Bus Continuity, Phasing and Contact Resistance/Ductor Test

- Check the continuity for each phase and phasing
- Check the resistance for all bus bar joint
- The main circuit resistance shall be performed from panel to panel on each phase from cable spouts with all circuit breakers racked in service and on position

5.3.2.2.2 Circuit Breaker Test

- **Contact Resistance Measurements** – with the circuit breaker closed, measure the resistance of all phases and record the readings
- **High-Pot Test and Insulation Resistance**
 - **Insulation Resistance Test at 5kVDC**
 - **With the CB Closed** – With the Y and B phases connected to earth apply the test voltage to R phase and record the corresponding Insulation Resistance readings. Repeat for all other phases.
 - **With CB Open** – Connect R, Y and B phases to earth and apply the test voltage to the bus side to the CB and record the corresponding Insulation Resistance readings
 - **High-Pot Test** – The test will be carried out at a test voltage of 30kV for 60sec
 - **With the CB Closed** – With the Y and B phases connected to earth apply the test voltage to R phase and record the corresponding leakage current readings. Repeat for all other phases.
 - **With CB Open** – Connect R, Y and B phases to earth and apply the test voltage to the bus side to the CB and record the corresponding leakage current readings
 - **Insulation Resistance Test of All Low Voltage Wiring and cabling at 500VDC** – connect all the wires together (+ve and -ve) or (L and N) and apply the test voltage between the wires and ground and record the corresponding Insulation Resistance readings.
- **Functional Check of Trip Free and Anti Pump Circuits** – Test all the Anti-Pump feature in the CB and it should be noted from the results that the CB does not attempt to re-close if a permanent closing signal is applied.
- **Functional Check of Breaker Operation Counter**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- **Check Correct Operation of All Auxiliary Contacts (For Breaker Open/Closed Positions)**
- **Timing Test using an Electronic Oscillograph** - Perform the Close (C), Open (O), Close-Open (C-O) & Open-Close-Open (O-C-O) and record the corresponding readings
- **Check The Correct Functioning of Interlocks and Limits Switches**

5.3.2.2.3 Current Transformer Test

- **Insulation Resistance Test** – the insulation resistance shall be checked at the terminal with respect to earth with 1kVDC voltage for 1 minute
- **Winding Resistance Test** – take CT resistance measurement at the terminals or terminal blocks in the LV compartment
- **Polarity Test** – check the CT polarities on the terminals as per the schematic drawing in the LV compartment for correct polarity.
- **Magnetizing Current Test** – check the Magnetization Curves by gradually increasing voltage to the CT Secondary and noting the magnetization current.
- **Ratio Test by Current Primary Injection** – check the CT ratio by injecting 25%, 50%, 75% and 100% (if possible) of the normal current on the CT primary winding and measure the corresponding secondary winding current.
- **Loop Resistance Measurement Test (Burden Test)** – Check the CT Loop Resistance at the extreme end terminals to ensure the complete loop
- **Phase Identification Test** – Check the Phase identification test by injecting single-phase primary current and check the secondary current in all phases. The secondary current should be zero in all phases except the one is being injected on.
- **Verify Secondary Circuits, Terminals, Shorting/Isolation Links by Primary Injection** – after primary injection test and with the same arrangement check that the secondary circuit CT terminal shorting / isolation is actually working by closing the shorting link / open the slide link and check the current.
- **High Voltage Test** – during the normal test on switchgear, the CT's are included in the HV test.
- **Single Point Earthing Check** – It is imperative to ensure that only one end of the CT Secondary is earthed especially where CT's are paralleled.
- **Demagnetize CT Cores After All Test** – after performing all mentioned test for the CT, apply voltage greater than the knee point voltage gradually to the CT secondary winding and go back gradually to zero voltage

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

5.3.2.2.4 Voltage Transformer Test

- **Insulation Resistance Test** – the insulation resistance shall be checked at the terminal with respect to earth with 1kVDC voltage for 1 minute
- **Winding Resistance Test** – take VT resistance measurement at the terminals or terminal blocks in the LV compartment
- **Ratio Check** – Apply 2 & 3 kV on VT primary terminal and the corresponding output on the VT secondary terminal and calculate the VT turns ratio
- **Polarity Test** – check the VT polarities on the terminals as per the schematic drawing in the LV compartment for correct polarity.
- **Check VT HV Neutral Solidly Grounded**
- **Verify Secondary Circuits, Terminal to Terminal for Correctness and Tightness**
- **Loop Resistance Measurement Test (Burden Test)** – Check the VT Loop Resistance at the extreme end terminals to ensure the complete loop

5.3.2.2.5 Testing of Metering Accuracy by Secondary Injection

- Metering calibration shall be tested via front panel mounted test facilities
- Maximum demand indicator (MDI) meters shall be tested as 10% and 100% of full scale
- Current and voltage metering and transducers calibration shall be tested at 0, 25, 50 and 100% of scale
- Power (W and Var) metering calibration shall be tested at 10% and 100% of rated current at angles of 0°, 45°, 90°, 180°, 225°, 270° and 315°
- Energy (kWh and kVarh) metering calibration shall be tested at 10% and 100% of rated current at angles of 0°, 45°, 90°, 180°, 225°, 270° and 315°
- Power factor metering and transducers calibration shall be tested at rated voltage and at 50% lead, unity, 50% lag power factors at 10%, 50% and 100% rated current
- Use red and green tags for tested meters. All meters tested and found ok must have green tags and meters tested and found defective shall be tagged red and shall be replaced.

5.3.2.2.6 Testing of Protection Relays by Secondary Injection

- LNW to provide all relay settings to the Contractor as required otherwise a Specialist Protection Engineer will be employed to do detailed fault level and protection studies and produce required protecting relay settings
- The Contractor's Test Engineer shall provide the relay commissioning manuals

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

which shall outline the detailed testing and commissioning procedure

- All outputs / indication to be tested
- Relay auxiliary devices such as external resistors, etc. to be tested to conform to required ratings and manufacturer's information
- Final calibration test of all protective relays must be carried out on approval settings, by secondary injection at the front panel mounted test facilities
- Auxiliary and tripping relay testing shall include
 - Pickup and dropout voltage verification of all contacts
 - Operation timing at 80% and 100% voltage
 - Time delay relays shall be tested at 0%, set point and 100% delay
- Use red and green tags for tested relays. All relays tested and found ok must have green tags and relays tested and found defective shall be tagged red and shall be replaced
- The relays commonly used in the LNW MV Reticulation Network includes
 - Feeder Protection Relays
 - Incomer Protection Relays
 - Motor Protection Relays

5.3.3 Warranties

After completing all the checks and tests and repairs, the Contractor shall give LNW a one (1) year warrantee from the date of final testing and re-commissioning. The re-commissioning date and reports to be submitted to LNW Operations/Maintenance for monitoring

5.3.4 Access to sites

The Contractor shall ensure that all necessary road clearance permits and approvals are received and that access routes to and from site are all times kept serviceable

5.3.5 Transportation requirements

In the event where the transformer is to be moved from site to a temporary refurbishment facility, the Contractor shall ensure that impact recorders are installed on the unit. The impact recordings shall be logged at the commencement of the journey and at the end of the journey. These results shall accompany the transformer to its final destination and be included in the transformer test and certification documentation package that shall be submitted by the Contractor and received by LNW responsible person at the handover of the unit.

5.3.6 Security

All equipment shall be safely stored and protected against possible theft or damage. All equipment

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

shall be the Contractor's responsibility for the duration of the project.

5.3.7 Site rehabilitation

After completion of the project the Contractor shall as part of de-establishing site, ensure that the site is clean and returned to its original state any damage shall be repaired. All surplus and dismantled equipment and material shall be disposed by the contractor.

If there is oil spillage it shall be reported to LNW and a detailed report on how spillage occurred and the procedure to the removal of the oil from the spill shall be given to LNW. The oil spill shall be managed by a specialist contractor and on completion of the process to rehabilitate, the clearance certificate shall be submitted to LNW.

5.3.8 Site Acceptance Test

- A full site acceptance test shall be performed to include full electrical and mechanical tests.
- Site acceptance test shall be witnessed by LNW.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

ANNEXURE A: ONSITE TESTING, MAINTENANCE AND/OR REFURBISHMENT

Item	Description of the job	Yes/No	Comments
1	SITE ESTABLISHMENT		
2	VISUAL INSPECTION		
	Visual Inspection of Indoor Switchgear Equipment		
2.1	Check nameplate information for correctness.		
2.2	Inspect enclosures for proper alignment, foundation fixing earthing.		
2.3	Inspect all covers, panels section and doors for paint work and proper fit.		
2.4	Check operations of all mechanical interlocks		
2.5	Check tightness of all bolted connections (torque wrench method)		
2.6	Check bus and supports for defects such as cracked welds, chipped porcelain, cracked insulation, etc. and free of dust accumulation		
2.7	Perform mechanical check and visual inspection on all circuit breakers		
2.8	Perform mechanical check and visual inspection on all current transformers		
2.9	Perform mechanical check and visual inspection on all voltage transformers		
2.10	Perform mechanical check and visual inspection on all disconnected and earthing switches Verify all front panel mounted devices (meters, push buttons, switches, indicator lamps, mimic buses, etc.) are installed as per drawings		
3	TESTING OF MV SWITCHGEAR AND ASSOCIATED EQUIPMENT		
3.1	Bus Continuity, Phasing and Contact Resistance/Ductor Test		
3.2	Circuit Breaker Test		
3.2.1	Contact Resistance Measurements		
3.2.2	High-Pot Test and Insulation Resistance		
3.2.3	Insulation Resistance Test at 5kVDC - With the CB Closed - With CB Open		



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

2.3.4	High-Pot Test ○ With the CB Closed ○ With CB Open		
2.3.5	Insulation Resistance Test of All Low Voltage Wiring and cabling at 500VDC		
2.3.6	Functional Check of Trip Free and Anti Pump Circuits		
2.3.7	Functional Check of Breaker Operation Counter		
2.3.8	Check Correct Operation of All Auxiliary Contacts (For Breaker Open/Closed Positions)		
2.3.9	Timing Test using an Electronic Oscilloscope		
2.3.10	Check The Correct Functioning Of Interlocks And Limits Switches		
3.3	Current Transformer Test		
3.3.1	Insulation Resistance Test		
3.3.2	Winding Resistance Test		
3.3.3	Polarity Test		
3.3.4	Magnetizing Current Test		
3.3.5	Ratio Test by Current Primary Injection		
3.3.6	Loop Resistance Measurement Test (Burden Test)		
3.3.7	Phase Identification Test		
3.3.8	Verify Secondary Circuits, Terminals, Shorting/Isolation Links by Primary Injection		
3.3.9	High Voltage Test		
3.3.10	Single Point Earthing Check		
3.3.11	Demagnetize CT Cores After All Test		
3.4	Voltage Transformer Test		
3.4.1	Insulation Resistance Test		
3.4.2	Winding Resistance Test		
3.4.3	Ratio Check		
3.4.4	Polarity Test		
3.4.5	Check VT HV Neutral Solidly Grounded		
3.4.6	Verify Secondary Circuits, Terminal to Terminal for Correctness and Tightness		
3.4.7	Loop Resistance Measurement Test (Burden Test)		
3.5	Testing of Metering Accuracy by Secondary Injection		
3.6	Testing of Protection Relays by Secondary Injection		
3.6.1	Feeder Protection Relay		



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

3.6.2	Incomer Protection Relay		
3.6.3	Motor Protection Relay		

Tender Number: _____

Tender's Authorised Signatory: _____

Name in block letters Signature

Full Name of Tendering Company: _____

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ANNEXURE B: ADDITIONAL ACTIVITIES

Any additional activities offered to the above checklist shall be listed below with reasons for additions			
Item	Description of the job	Yes/No	Comments

Tender Number: _____

Tender's Authorised Signatory: _____
Name in block letters Signature

Full Name of Tendering Company:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.10.13 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- IEC 60529 - Degrees of Protection of Enclosures for Low Voltage Switchgear and Control-gear
- SANS 60947 - Low-voltage Switchgear and Control gear:
 - Pt 1 General rules
 - Pt 2 Circuit breakers
 - 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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
• 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)



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

- 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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 35mm², crimped with lugs

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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**

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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/mm².

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	Witness 1	Witness 2

- 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 25mm². 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 16mm²

iii. **Earth Bar**

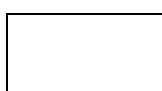
A continuous copper main earth bar or minimum cross-sectional area 70mm² shall extend the whole length of each Motor control centre. This earth bar shall, at least, be bolted to the switchgear housing at each vertical section. Crimp type terminals for 70mm² stranded copper shall be provided at both ends of the earth bar for connection of LNW earthing.

iv. **Wiring**

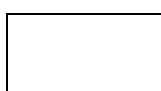
Each Motor control centre shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transport.

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.

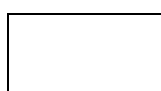
CT Wiring	-	2.5mm ² phase coloured, common return black insulated, earth link.
General Control Wiring	-	(AC) 1.5mm ² grey (DC) 1.5mm ² (positive – red, negative – black)



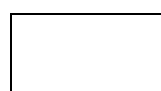
Contractor



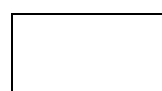
Witness 1



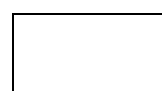
Witness 2



Employer



Witness 1



Witness 2

LED"s and PLC Inputs	-	(AC) 0.75mm ² grey (DC) 0.75mm ² (positive – red, negative – black)
Control Neutral	-	(AC) 2.5mm ² black
Terminal Links	-	2.5mm ² 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:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- 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 “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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- 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 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- 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 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

ix. **Labelling 5mm²**

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 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:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- 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.

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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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
Overall Appearance	
• 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.)	
Busbars	
• Correct cross-section	
• Correct phasing with incomer/outgoers	
• Rigidly supported/braced	
• Properly insulated	
• Joints tightened	
• Transport section joints supplied (fishplates, nuts and bolts, control wiring and terminals, etc.)	
• Droppers from main bars to circuit breakers adequately rated, braced, insulated	
• Nothing unnecessary mounted on bus bars	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

• Main earth bar, min 70mm ²	
• Air clearances adequate throughout	
Incoming Circuits	
• Correct size/rating of ACB's or MCCB's	
• Correct metering and proper mounting	
• Connection of power factor meter	
• Fuses on voltmeter, where applicable	
• Reasonable provision for termination of incoming cable/gland plate	
• Air clearances correct throughout	
Outgoing Circuits	
• Correct size/rating for ACB's, MCCB's or MCB's	
• Correct earth leakage relays	
• Correct current transformer and associated ammeters	
• Correct overload relays	
• Correct setting on overload relays	
• Reasonable provision for cable termination power and control mounting of equipment	
• Correct conductor sizing, power and control, and correct colouring	
• Correct indicator lights and colours	
• Air clearances correct throughout	
Simulation and Injection Tests	
• 2kV pressure test on all 400V parts of the board, with contactors de-energised and circuit breakers closed, excluding control supply	
• Primary injection test for correct operation of all protection and overload relays	
Operational Test	
• Mechanical operation of all circuit breakers, preferably with doors closed	
• Shunt trip of all circuit breakers	
• Operation of overload relay	
• Correct operation of all interlocks	



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

• Correct operation of indicating lights/lamps	
• Correct operation of earth fault/overload alarm system, including general alarm panel	
General Checks	
• Marking of control wires and power conductors	
• Main Motor control centre label	
• Cubicle labels fitted – designation and cubicle number	
• Component labels fitted	
• Warning labels on all removable covers giving access to live 400V conductors	
• Labels for indicator lights, pushbuttons, etc.	
• Terminal strip labels	
• Incoming side of circuit breakers label	
• Incoming circuit label – “FROM _____”	
• No Philips (star) and self-tapping screws	
• Grommets fitted on all open holes	
• Correct paint specification	
• All documentation submitted	
• Door latches fitted	

Tender Number: _____

Tender's Authorised Signatory: _____
Name in block letters Signature

Full Name of Tendering Company:



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.10.14 PSE - 05: PARTICULAR SPECIFICATION FOR NICKEL CADMIUM BATTERIES

1. Introduction

DC supply for an integral part of LNW electrical network and it is used for electrical substation and pumpstation backup supply for protection and control systems. Nickel cadmium batteries are part of this supply and are required for the stable supply for the protection and control systems.

2. Scope

The purpose of this specification is to detail the technical requirements for vented prismatic nickel cadmium battery cells in LNW substations and pumpstations.

3. Normative References

The following standards and specifications contain provisions that, through reference in the text, constitute requirements of this specification. 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 60623	-	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells
• IEC 60417	-	Graphical Symbols for Use on Equipment
• SANS 10142	-	

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
- NRS - National Rationalisation of Specifications



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

NOTE: The opening may be fitted with a venting system

Witness 2

Application	Indoors
Altitude	The design shall be based on an altitude of 1800m a.m.s.l
Maximum ambient air temperature	Hottest anytime 40°C Hottest monthly average 30°C
Yearly average ambient air temperature	20°C
Minimum ambient air temperature	Coldest anytime -10°C
Variation in humidity	10% to 90%
Area	High lightning area

5.3 Parameter Measurement Tolerances

The overall accuracy of controlled or measured values, relative to the specified or actual values shall be within the following:

- Voltage - $\pm 1\%$
- Current - $\pm 1\%$
- Temperature - $\pm 2^{\circ}\text{C}$
- Time - $\pm 0.1\%$
- Capacity - $\pm 1\%$

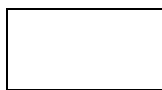
NOTE: These tolerances comprise the combined accuracy of the measuring instruments, the measurement techniques used, and all other sources of error in the test procedure.

5.4 Cells and Battery Banks

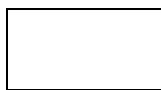
- The nominal voltage of each vented nickel-cadmium rechargeable single cell shall be 1,2 V as defined in SANS 60623.
- Only cells in plastic containers with two terminals and no lugs shall be accepted.
- Dimensions for vented nickel-cadmium prismatic cells in plastic containers shall comply to table 1b and table 2 in clause 3 of SANS 60623.
- The battery banks shall be designed for the following voltages as and when required by LNW
 - 30V, 48V, 110V, 220V

5.5 Cell designation

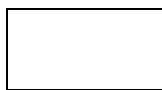
- Vented nickel-cadmium prismatic rechargeable single cell shall be designated by the letter “K”



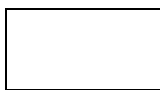
Contractor



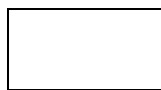
Witness 1



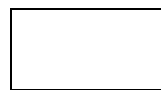
Witness 2



Employer



Witness 1



Witness 2

followed by a letter “**L, M, H or X**” in accordance to clause 2.1 of SANS 60623, which signifies the following:

- L – Low rate discharge up to 0.5 I_tA
- M – Medium rate discharge up to 3.5 I_tA
- H – High rate discharge up to 7.0 I_tA
- This group of two letters shall be followed by a group of figures indicative of the rated capacity of the cell in ampere-hours. For example: KH 185.
- Cells in cases of plastic material shall be designated by the letter "P" after the figures. For example: KH 185 P.

5.6 Markings

Each cell shall carry durable markings giving the following minimum information:

- Type of cell as specified in clause 6.2.2.1, and it is also permissible for manufacture to use their type of designation.
- Name or identification of the manufacture and/or supplier
- Positive terminal either a red washer and an indented or raised symbol in accordance to graphical symbol 5005 of IEC 60417.

5.7 Safety and maintenance

The manufacturer shall provide recommendation for the safe handling and maintenance of the cells.

6. Tests

The vented nickel-cadmium rechargeable single cell type tests: routine test and sample test set out SANS 60623 shall apply to this specification.

6.1 Type Test

Type tests shall be carried out in accordance with SANS 60623

- General
- Mechanical tests
- Electrical tests

6.2 Routine Test and Factory Acceptance Test (FAT)

- Routine Tests shall be carried out in accordance with SANS 60623.
- Factory Acceptance Test (FAT) shall be carried out in accordance with SANS 60623 unless stated otherwise, with the presence of LNW Personnel before vented nickel-cadmium rechargeable single cell are released from the manufacturer if necessary.
- List of tests to be witnessed shall be as follows:

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- Discharge performance test at 20 °C
- Discharge performance test at +5 °
- Discharge performance test at -18 °C
- High-rate current test
- Charge retention test
- Endurance test in cycle
- Permanent charge endurance
- Charge acceptance at constant voltage test
- Electrolyte retention test

Note: LNW reserves the right to request to approve prototype testing before any ordering can commence

6.3 Sample Test

- Sample Tests shall be carried out in accordance with clause 7 of SANS 60623.
 - Type approval
 - Batch acceptance
- Physical appearance tests
 - Visual inspection shall be performed on cells. No cracking, damage or corrosion shall be apparent. Any deformation shall be within the tolerances of the dimensions specified in the manufacturer's drawings.

7. Marking, Labelling and Packaging

Marking, labelling and packaging shall comply with the requirements of SANS 60623.

8. Documentation

Documentation shall be submitted in a catalogue format (Both physical and electronic). In addition, relevant test results and certificates confirming compliance clause 6 of this document shall be submitted.

9. Storage

Cells storage shall comply to clause 4.9 of SANS 60623.

10. Training

Further refer to Sub-Clause PS 4.11.7, PS 6.1.5 & PS 7.7

A necessary certified training course shall be offered to relevant LNW staff. The training shall include, amongst other things, the handling, storage, safety, maintenance and installation of the vented nickel-cadmium prismatic rechargeable single cell.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Tender Number: _____

Tender's Authorised Signatory: _____

Name in block letters

Signature

Full Name of Tendering Company: _____

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.15 PSE - 06: PARTICULAR SPECIFICATION FOR 33/6.6kV POWER / DISTRIBUTION TRANSFORMERS RATED FROM 5000kVA TO 20 000kVA

1. Introduction

This particular specification applies to all new power/distribution 33/6.6kV transformers, of ratings from 5000kVA to 20 000kVA that will be procured and installed at LNW's Olifantspoort Water Supply Scheme.

2. Scope

This particular specification covers the design, manufacture, supply factory testing, delivery site and assembling on site, testing and commissioning of oil filled power/distribution transformers.

3. Normative References

The transformers offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS 780:2004. The units offered will have the SABS mark of approval. Any deviation from these conditions will be clearly indicated, and any equipment so offered will only be used with the express permission/concession, in writing, of the LNW or LNW's representative. The equipment offered and work performed, shall comply with the requirements of the governing Occupational Health and Safety Act

Transformer shall be produced in a factory with a SANS ISO 9001 accredited quality system

- OHS Act 85 of 1993 - Occupational Health and Safety Act, Act No. 85 of 1993
- NRS 054 / SANS 60078 - Power Transformers
- SANS 780 - Distribution Transformers
- NRS 079 - Mineral insulating oils (uninhibited and inhibited)
- SANS 1091 - National Colour Standard
- SANS 555 - Unused and reclaimed mineral insulating oil for transformer and switchgear
- SANS 61958 - Indicating Devices
- SANS 60076-1 - Power Transformer – Part 1: General
- SANS 60076-2 - Power Transformers – Part 2: Temperature rise
- SANS 60076-3 - Power Transformers – Part 3: Insulation level and dielectric tests
- SANS 60076-4 - Power Transformers – Part 4: Guide to lightning impulse and switching impulse test: Power transformers and reactors

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- SANS 60076-5 Power Transformer – Part 5: Ability to withstand short circuit
- SANS 60076-7 - Power Transformer – Part 7: Load guide for oil immersed power transformers
- SANS 60076-10 - Power Transformer – Part 10: Determination of sound levels
- SANS1400 Environmental systems – Requirements with guidance for use
- SANS 12944 - Paints and varnishes – Corrosion protection of steel structures by protective paint systems
- SANS 10064 - The preparation of steel surfaces for coating

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
- 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
- PCB - Polychlorinated biphenyl's
- DGA - Dissolved Gas Analysis
- SAT - Site Acceptance Testing
- V - Volt
- kVA - Kilovolt-amperes
- MVA - Megavolt-amperes
- A - Amperes
- kV - kiloVolt
- ORHVS - Operating Regulations High Voltage Systems
- CT - Current transformer



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- a.m.s.l - above mean sea level
- CoC - Certificate of Compliance
- NER - Neutral Earthing Resistor
- ONAN - Oil Natural Air Natural
- ONAF -- Oil Natural Air Forced
- OFAF - Oli Forced Air Forced
- OFWF - Oil Forces Water Forced

5. Requirements

In addition to the requirement of SANS 780, the following will also be considered.

5.1 General

The transformer vector symbol shall be Dyn11 as per SANS 780 unless otherwise specified in the detailed specification.

Total and component losses shall not exceed 10%.

The nominal voltages (primary and secondary) will be as specified in the detailed specification/data sheet.

Transformers will have a removable top lid for maintenance and repair purposes. The lid must be fixed with bolts and nuts, sized to contain integrity of the transformer tank under all circumstances.

All openings on the transformer tank must be sealed with cork gaskets.

Transformers offered will be painted and finished in accordance with SANS 780

Nothing in this standard shall lessen the obligation of the contractor. The contractor shall be fully responsible for the testing, maintenance, repairs and refurbishment of the power transformers and its satisfactory performance in service. Approval by SMMMS/LNW shall not relieve the contractor of the responsibility for the adequacy of the maintenance, repairs and refurbishment.

5.2 Cooling Method

The cooling method used shall be the method represented by the symbol group ONAN in accordance with SANS 780

5.3 Service Conditions



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The requirements in this specification apply to transformer for use under the following general condition in Table 1.

Table 1: Atmospheric Conditions

Environment	Limits
Application	Outdoors
Altitude	The design shall be based on an altitude of 1800m a.m.s.l
Maximum ambient air temperature	Hottest anytime 40°C Hottest monthly average 30°C
Yearly average ambient air temperature	20°C
Minimum ambient air temperature	Coldest anytime -10°C
Variation in humidity	10% to 90%

5.4 Insulation

The winding insulation shall be of uniform nature, i.e. non-graded. The copper conductors shall be covered by thermally upgraded paper. The rating shall be as describe in Table 2 below

Table 2: Winding Insulation (based on SANS 60076-3)

Nominal Voltage (kV) Un	Highest Voltage (kV) Um	Rated short duration power-frequency voltage (kV) at 50 Hz	Rated peak lightning impulse withstand voltage (kV)
33	36	88	200
22	24	50	125
11	12	28	95
6.6	7.2	28	95

5.5 Windings

HV and LV windings shall be wound from aluminium conductor. All internal busbars must be aluminium. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

The paper strength shall exceed a degree of polymerisation (DP) of 1100 as per IEC 60450.

5.6 Oil

The transformers will be provided and delivered filled with the required quantity of insulating oil. Should the transformer be delivered with the conservator tank separate from the transformer (dismantled),

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

the supplier will be responsible for assembling the transformer on site and filling it with oil. The oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling. The oil shall be filled under vacuum. All oil shall be new and the use of recycled oil is not acceptable. The oil shall comply with SANS 555.

5.7 Bushing insulators

- Bushing insulators shall comply with the requirement of SANS 60137. Old bushing shall be tested to ensure their compliance to the standard.
- Every busing shall be supplied complete with an air-side bushing terminal that shall be suitable for connecting the system to an aluminium conductor of diameter 26 mm
- The design of insulators for 33kV and above shall be such as to minimize corona discharge and radio interference and shall have test tapings
- Connections from main windings to bushings insulators shall be flexible
- High and low voltage bushings shall be supplied with external connectors
- Clamps and fittings shall be made of steel or malleable iron and shall be galvanized
- Bushings shall be stored in accordance with manufacturer's instructions

6. Tap Changer Switch

A off-load tap changer switch shall be installed. The switch shall have 5 tap positions, i.e. - 5%, - 2.5%, Normal, + 2.5%, + 5%.

Tap changing shall be carried out by means of an externally operated self-position switch. Provision shall be made for locking the taping switch handle in position. The tap setting shall be clearly visible in each step. The displayed tap numbers shall be referenced on the diagram plate.

7. Fixtures

7.1 Conservator Tank

A conservator tank shall be provided on the transformer tank as per SANS 780.

7.2 Primary Side

MV side shall be provided with bushings as per item 5.7 above. Bushings shall be marked by letters 1U, 1V, 1W.

7.3 Secondary Side Cable Box

The transformer shall be fitted with a suitable LV cable box having non-magnetic material gland plate with appropriately sized single compression glands on LV side to terminate (bottom cable entry unless otherwise specified in the detailed specification/datasheet) 6.6kV/single core XLPE unarmoured cable (size as per detail requirement). Bushings shall be marked by letters 2U, 2V, 2W. The neutral point



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

terminal shall be indicated by the letter 2N. Neutral terminal is to be brought out and terminated to the tank earthing point.

7.4 Jacking Pads and Lifting Lugs

Sufficient jacking pads shall be fitted to jack the oil-filled transformer into position. The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted without the use of a sling spreader bar. A lifting procedure must be supplied.

7.5 Wheels

Transformers must stand on skids. No wheels will be allowed.

8. Auxiliary Equipment

The required auxiliary equipment to be included are specified in the detailed specification.

8.1 Oil Level Gauges

Oil level gauges shall be flush mounted with the gauge glass (of plastic material) securely attached to the tank throughout its length by means of a metal shroud. The oil in the gauge will not be in contact with the air outside the tank.

8.2 Air Breather

Silica gel air breathers shall have a window for inspection of the condition of the silica gel and oil cup or other device to prevent continuous contact of the silica gel with the air outside the transformer.

8.3 Buchholz Relays

Buchholz relays shall be of the double float or bucket type and shall be of approved manufacture. The gas release cock for the relay shall be placed within easy reach from ground level and connected to the relay by small-bore non-ferrous tubing. The sight window of the relay will be clearly visible from ground level. The Buchholz relays will be equipped with a set of alarm and trip contacts.

8.4 Dual-type Thermometers

Dual-type thermometers will be graduated in °C for registering "top oil" temperatures. The instrument will be provided with resettable maximum-temperature indicator and a pair of adjustable alarm contacts that can be set to close at a predetermined temperature. An additional set of adjustable contacts will be provided for tripping purposes. All thermistors or other in oil pockets. Unused thermometer pockets will be fitted with a captive screw cap.

8.5 Pressure Relief Devices

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

One spring operated pressure relief device shall be provided.

8.6 Oil Filling Point

A point must be provided to fill the oil level up. The point must be of the screw type and be sealed to prevent air intake when not in use.

8.7 Oil Training Point

A drain point must be provided to drain the oil from the transformer tank. A shut-off valve must be installed at the drain point. The drain point must be sealed with a screw type cover when not in use.

8.8 Alarm and Trip Contacts

All alarm contact will be capable of breaking up to 20W DC, inductive, at the specified alarm and tripping voltages.

All contacts will be capable of making and carrying for 0.5 sec, a current corresponding to 150W at the specified alarm and tripping voltage.

All auxiliary relays associated with tripping shall be DC operated and suitable for the specified alarm and tripping currents.

Alarm and tripping contacts will be provided with un-grounded and electrically independent circuits.

9. Painting

The interior and exterior surfaces of a tank, the tank cover and the conservator tank shall be abrasive blast-cleaned or pickled, rinsed and dried (SANS 10064)

- Corrosion protection

A corrosion preventative layer will be applied to the interior surfaces of the transformer. The transformer and cooling radiators will be painted as specified in SANS 780 and SANS 12944.

- Final Coat Colour

The colour of the final paint coat is C12 Avocado Green (6022-G91Y) according to SANS 1091 unless specified otherwise in the detailed specification.

- Damaged Paintwork

Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied

10. Test Requirements

Routine factory acceptance tests (FAT) in accordance with SANS 780 shall be performed at the

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

supplier's facility prior to delivery. Type tests and special tests to SANS 780 shall be performed on one transformer of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical transformers. The following routine tests will be carried out on the transformer as a minimum (The tests are described in SANS 780). LNW reserves the right to witness the FAT tests.

- Measurement of winding resistance
- Insulation resistance measurement
- Measurement of voltage ratio
- Impedance test
- Vector group test
- Measurement of transformer losses
- Induced over voltage test
- Separate source voltage withstand test
- Tank effectiveness of sealing

The results of these tests will be made available to LNW for their evaluation prior to acceptance and delivery of the transformers. Two copies of test results will be provided to LNW.

The contractor must arrange for site acceptance tests (SAT) on all transformers. A schedule of all tests to be done must be provided by the contractor for approval prior to commencement of manufacture. The SAT must be witnessed by LNW or the client's representative. The results of the SAT will be recorded and issued to LNW.

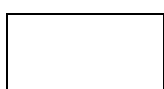
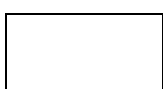
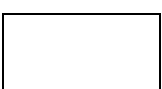
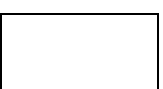
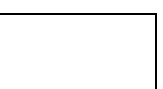
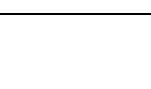
The contractor shall arrange for thermal imaging of the transformer a minimum of 1 week after commissioning and while the transformer is in continuous use. The results of the imaging and SAT are to form part of the deliverable Operations and Maintenance Manuals.

11. Drawings

Tenderers shall furnish the following drawings together with their tenders:

- Outline drawings of the transformers, showing:
 - All external fittings
 - Typical mass of the transformer with and without oil
 - Typical volume of transformer oil
 - The most important external dimensions.
- Details of MV and LV bushings

The successful tenderer will provide three copies of each of the following drawings, to the Engineer,

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

before manufacturing may commence

- General Arrangement drawings indicating
 - External fittings
 - Lifting lugs and lifting requirements
 - The mass of the transformer with and without oil
 - The volume of the transformer oil
 - Transformer dimensions with free space required
 - The transformer rating plate (to SANS 780)
- The internal construction of the transformer and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings
- A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings
- Schematic drawings of the alarm and trip circuits

12. Sound Level

During design and manufacture of transformers, care should be exercised to limit transformer noise and vibration to within the parameters as recommended in SANS 780.

13. Transformer Losses

Low loss transformers are required for by this particular specification. Accordingly, LNW shall retain the right to either not accept the transformers offered or to call for changes to be made to the transformers before acceptance.

Should in LNW's opinion, either the no-load losses or the full-load losses of the transformers supplied by the successful tenderer exceed the loss figures specified in the tender, by a quantity exceeding the permissible tolerances in accordance with SANS 780. Any such changes, called for by LNW, will be for the account of the tenderer/contractor.

Where any transformer is accepted with reduced performance figures and where tolerances exceed the provisions of paragraph 4.9 of SANS 780, the tender price will be adjusted and reduced by a sum equal to the capitalized value of the excess losses, calculated in accordance with the following capitalization formula:

$$K = 1,46 V + 2,86 N$$

Where:

K = capitalized value of the losses in South African Rand (ZAR)

V = full - load losses at normal voltage and frequency, in watts

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

N = No - load losses at normal voltage and frequency, in watts

In view of adjusting the tender price, the said excess losses shall be taken as the quantity by which the actual losses exceed the loss figure in the tender document, without taking into consideration the permissible tolerances in accordance with SANS 780.

The no - load and full – load losses will be taken into consideration independently when calculating the adjustment of the tender price. Low full-load losses will not be able to compensate for high no-load losses, or vice versa.

Neither will the tender price be increased, should the actual no-load losses and/or full load losses be less than the losses tendered. The above formula with V and N will be used in adjudicating the tender

14. Identification Tags

All data on the identification tags shall be in SI units

15. Testing and Commissioning

During testing and commissioning, the contractor shall:

- Perform a transformer oil test prior to livening of the transformer
- Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications
- Ensure the rating of all equipment is as specified
- Test the function of all alarm and trip signals to ensure the transformer circuit breaker trips as required
- Do a transformer insulation resistance test (as described in SANS 780).
- When the transformer is on load, the correct tap changer setting must be determined. Tap setting changes can only be done off-load

16. Quality Assurance

A quality management plan shall be set up in order to assure the proper quality management of the transformer during design, development, production, installation and maintenance. Guidance on the requirements for a quality management plan may be found in the ISO 9001. The details shall be subject to agreement between LNW and supplier/manufacture.

Foreign and third-party manufacturers, shall, in addition, hold valid certification of their quality management system. Such certification shall be from a national quality systems certification body (Registrar), duly accredited by a QMS accreditation body, which is signatory to a mutual recognition

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

agreement with South Africa.

17. Environmental Management

An environmental management plan shall be set up in order to assure the proper environmental management of transformers throughout its entire life cycle (i.e. during design, development, production, installation, operation and maintenance, decommissioning and disposal phases).

Guidance on the requirements for an environmental management system may be found in ISO 14001 standards. The details shall be subject to agreement between LNW and supplier/manufacturer. This is to ensure that the asset created conforms to environmental standards and LNW SHEQ Policy.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

ANNEX A – TECHNICAL SCHEDULE A AND B

Schedule A: Purchaser's Specific Requirements

Schedule B: Guarantees and Technical Particulars of Equipment Offered

Item	Subclause of SANS 780	Description	Requirement	Schedule A	Schedule B
1		Name of manufacturer		xxxxxx	
2		Place of manufacture		xxxxxx	
3	4	Rated Power	kVA	20 000	
4	4.5	Primary voltage	V	33 000	
5	4.5	Secondary voltage	V	6 600	
6	4.5	Number of phases	Single phase / Three phase	Three Phase	
7	4.6	Insulation level			
		a) Primary side	kV	xxxxx	
		b) Secondary side	kV	xxxxx	
8		Does the transformer bear SABS mark?	Yes/No	Yes	
9	8.3	Transformer dimensions (height)	mm	xxxxxx	
10	8.3	Transformer dimension (width)	mm	xxxxxx	
11	8.3	Transformer dimension (length)	mm	xxxxxx	
12	8.3	Transformer mass (without oil)	kg	xxxxxx	
13	8.3	Transformer mass (with oil)	kg	xxxxxx	
14		Oil capacity	l	xxxxxx	
15	8.4	Tank type	Sealed / free breathing	Free breathing	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Item	Subclause of SANS 780	Description	Requirement	Schedule A	Schedule B
16	8.9.4	Expansion space	%	xxxxx	
17	8.9.11	Pressure-relief device	Yes/No	Yes	
18	8.10	Conservator	Yes/No	Yes	
19	8.24.3	Cooling method	ONAN/ONAF/OFAF/ OFWF	xxxxxxx	
19	8.14	Primary bushing type		Outdoor	
20	8.14	Primary bushing material	Procelain / Silicone	xxxxxx	
21	8.14	Primary bushing creepage distance	mm/kV	31	
22	8.14	Primary Stem diameter		M12	
23	8.14	Secondary bushing material	Procelain / Silicone	xxxxxxx	
24	8.14	Secondary bushing creepage distance	mm/kV	31	
25	8.14	Secondary Stem diameter		M12	
26		Flag supplied?	Yes/No	Yes	
27		Oil level gauge fitted?	Yes/No	Yes	
28		Primary winding material	Copper/Aluminium	xxxxxxx	
29		Secondary winding material	Copper/Aluminium	xxxxxxx	
30		Secondary cables to be terminated			
31		Maximum no-load losses (Pi)	W		
32		Maximum load losses (Pc)	W		
33		Cost per kW of no-load losses (Ci)	R/kW		
34		Cost per kW of load	R/kW		

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Item	Subclause of SANS 780	Description	Requirement	Schedule A	Schedule B
		losses (Cc)			
35		Impedance at principal tapping	%	4 to 5	
36		X/R ratio		xxxxx	
37	10.3	Type tests in accordance with SANS 780			
	10.3	c) temperature rise test	Ref. no.	xxxxx	
	10.3	d) lightning impulse test	Ref. no.	xxxxx	
	10.3	e) tank stiffness test	Ref. no.	xxxxx	
	10.3	f) corrugated tank fatigue test	Ref. no.	xxxxx	
	10.4.1	g) short-circuit withstand capacity test	Ref. no.	xxxxx	
	10.3	h) pollution test	Ref. no.	xxxxx	
38	10.4	Routine tests as per SANS 780			
		a) measurements of winding resistance	Ref. no.	xxxxx	
		b) measurement of voltage ratio and check phase displacement	Ref. no.	xxxxx	
		c) measurement of short-circuit	Ref. no.	xxxxx	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Item	Subclause of SANS 780	Description	Requirement	Schedule A	Schedule B
		impedance and load loss			
		d) measurement of no -load loss and current	Ref. no.	xxxxx	
		e) separate source test	Ref. no.	xxxxx	
		f) induced over voltage test	Ref. no.	xxxxx	
		g) measurement of paint thickness	Ref. no.	xxxxx	
		h) test for effective sealing	Ref. no.	xxxxx	
40		Packaging and marking	Yes/No	Yes	



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

C3.10.16 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
AC	:	Alternating Current
DC	:	Direct Current



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.
- (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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- (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.

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- (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.
- 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.



Contractor



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Witness 2



Employer



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- 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

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.



Contractor



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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.
- (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



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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.
- (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.



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All submersible motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the motors.

An adequate length of waterproof cable, purpose-made for submersion, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimize any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.

Thermistor protection temperature switches shall be provided for submersible motors.

Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed included in the rates tendered for the equipment.

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



Contractor



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- 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.
- 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.
- (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.

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- (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.
- (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.



Contractor



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Employer



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- (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.

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.



Contractor



Witness 1



Witness 2



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<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



Contractor



Witness 1



Witness 2



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Witness 1



Witness 2

C3.10.17 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
DC	:	Direct Current
GA	:	General Arrangement



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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. 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



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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.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 lightning 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:-

- 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



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Witness 1



Witness 2



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Witness 1



Witness 2

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

Item **Unit**
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

Item **Unit**
Install cable ladder m

The unit of measurement shall be per linear meter of cable ladder installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cable ladders installed under the Contract.

Item **Unit**
Supply and deliver horizontal bends No

The unit of measurement shall be the number of horizontal bends supplied and delivered. Separate items shall be scheduled to include for each size of horizontal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete horizontal bends

Item **Unit**
Install horizontal bends No

The unit of measurement shall be the number of horizontal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size horizontal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the horizontal bends installed under the Contract

Item **Unit**



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Supply and deliver vertical bends No

The unit of measurement shall be the number of vertical bends supplied and delivered. Separate items shall be scheduled to include for each size of vertical bend required under the Contract.
The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete vertical bends

Item **Unit**

Install vertical bends No

The unit of measurement shall be the number of vertical bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of vertical bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the vertical bends installed under the Contract.

Item **Unit**

Supply and deliver internal bends No

The unit of measurement shall be the number of internal bends supplied and delivered. Separate items shall be scheduled to include for each size of internal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete internal bends

Item **Unit**

Install internal bends No

The unit of measurement shall be the number of internal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of internal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the internal bends installed under the Contract.

Item **Unit**

Supply and deliver external bends No

The unit of measurement shall be the number of external bends supplied and delivered. Separate items shall be scheduled to include for each size of external bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete external bends.

Item **Unit**

Install external bends No

The unit of measurement shall be the number of external bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of external bend installed under the Contract.



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 external bends installed under the Contract

<u>Item</u>	<u>Unit</u>
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

<u>Item</u>	<u>Unit</u>
Install Tee-pieces	No

The unit of measurement shall be the number of Tee-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of Tee-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the Tee-pieces installed under the Contract

<u>Item</u>	<u>Unit</u>
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

<u>Item</u>	<u>Unit</u>
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

<u>Item</u>	<u>Unit</u>
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

<u>Item</u>	<u>Unit</u>

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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

Supply and deliver cable ladder support struts material m

Unit

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

Install cable ladder support struts No

Unit

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

Contractor

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Employer

Witness 1

Witness 2

C3.10.18 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

3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

LNW : Lepelle Northern Water



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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

<u>Item</u>	<u>Unit</u>
Supply and delivery of local start/stop isolator pushbutton stations	m

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.

C3.10.19 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
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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

SANS 60947	:	Low-voltage Switchgear and Control gear:
		Pt 1 General rules
		Pt 2 Circuit breakers
		Pt 3 Switches/Isolators/Switch Isolator and Combination Fuse Switch Units
		Pt 4 Contactors
		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

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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 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 70mm² 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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.
- 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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 35mm², 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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 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/mm².

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 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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 25mm². 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 16mm².

iii. Earth Bar

A continuous copper main earth bar or minimum cross-sectional area 70mm² 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 70mm² 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Control and instrumentation wiring shall be Silicone insulated throughout and of flexible, stranded, annealed, untinned copper construction. All wiring shall comply with the table below. Conductors shall comply with SANS 1411, Part 1, Table 4, Class 5.

CT Wiring	2.5mm ² phase coloured, common return black insulated, earth link
General Control Wiring	(AC) 1.5mm ² grey (DC) 1.5mm ² (positive – red, negative – black)
LED"s and PLC Inputs	(AC) 0.75mm ² grey (DC) 0.75mm ² (positive – red, negative – black)
Control Neutral	(AC) 2.5mm ² black
Terminal Links	2.5mm ² 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.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.
 - 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- 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 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

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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

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
225	250/5



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Employer



Witness 1



Witness 2

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 5mm²

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

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



Contractor



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Witness 1



Witness 2

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
- 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



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Witness 1



Witness 2

- 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 (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
	Data Sheets	Yes	3 Weeks after appointment
Quality Control Documentation (3 Sets of Hardcopies plus 1 Softcopy)	Quality Control Plan	Yes	3 Weeks after appointment
	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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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
Overall Appearance	
• 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)	



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Inspection/Testing	Comments
Lifting lugs provided	
Equipment supplied in accordance with specification (contractors, overloads, circuit breakers, relays, etc.)	
Busbars	
Correct cross-section	
Correct phasing with incomer/outgoers	
Rigidly supported/braced	
Properly insulated	
Joints tightened	
Transport section joints supplied (fishplates, nuts and bolts, control wiring and terminals, etc.)	
Droppers from main bars to circuit breakers adequately rated, braced, insulated	
Nothing unnecessary mounted on bus bars	
Main earth bar, min 70mm²	
Air clearances adequate throughout	
Incoming Circuits	
Correct size/rating of ACB's or MCCB's	
Correct metering and proper mounting	
Connection of power factor meter	
Fuses on voltmeter, where applicable	
Reasonable provision for termination of incoming cable/gland plate	
Air clearances correct throughout	
Outgoing Circuits	
Correct size/rating for ACB's, MCCB's or MCB's	
Correct earth leakage relays	
Correct current transformer and associated ammeters	
Correct overload relays	
Correct setting on overload relays	
Reasonable provision for cable termination power and control mounting of equipment	
Correct conductor sizing, power and control, and correct colouring	
Correct indicator lights and colours	
Air clearances correct throughout	
Simulation and Injection Tests	
2kV pressure test on all 400V parts of the board, with contactors de-energised and circuit breakers	



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Inspection/Testing	Comments
closed, excluding control supply	
Primary injection test for correct operation of all protection and overload relays	
Operational Test	
Mechanical operation of all circuit breakers, preferably with doors closed	
Shunt trip of all circuit breakers	
Operation of overload relay	
Correct operation of all interlocks	
Correct operation of indicating lights/lamps	
Correct operation of earth fault/overload alarm system, including general alarm panel	
General Checks	
Marking of control wires and power conductors	
Main Motor control centre label	
Cubicle labels fitted – designation and cubicle number	
Component labels fitted	
Warning labels on all removable covers giving access to live 400V conductors	
Labels for indicator lights, pushbuttons, etc.	
Terminal strip labels	
Incoming side of circuit breakers label	
Incoming circuit label – “FROM _____”	
No Philips (star) 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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>Item</u>	<u>Unit</u>
Commission Switchboards or Motor Control Centres	no

The unit of measurement shall be the number of MCC's or boards.

The tendered rates shall include full compensation for the site testing and commissioning of the specified boards including the keeping of all commissioning records in triplicate, including all material, test equipment and labour required for the testing and commissioning.

<u>Item</u>	<u>Unit</u>
Supply and install extra circuits on Switchboards and Motor Control Centres	no

The unit of measurement shall be the number of circuits supplied and installed.

The tendered rate shall include full compensation for the manufacture, supply, testing and installing of extra circuits in switchboards or motor control centres (spare space being available on the board).

<u>Item</u>	<u>Unit</u>
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.

<u>Item</u>	<u>Unit</u>
Supply and install extra circuits on Switchboards and Motor Control Centres	no

The unit of measurement shall be the number of circuits supplied and installed.

The tendered rate shall include full compensation for the manufacture, supply, testing and installing of extra circuits in switchboards or motor control centres (spare space being available on the board).

<u>Item</u>	<u>Unit</u>
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

<u>Item</u>	<u>Unit</u>
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.

<u>Item</u>	<u>Unit</u>

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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>Item</u>	<u>Unit</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

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

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Witness 2

C3.10.20 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
NRS	:	National Rationalisation of Specifications
SANS	:	South African National Standards
IEC	:	International Electrotechnical Commission



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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

Contractor

Witness 1

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Witness 2

- 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.

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 Lightning 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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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

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 3Ω (measured at low frequency) is required for earth termination systems. Should it be impossible to achieve this earthing resistance value, the Engineer must approve the value obtained and deemed reasonable.

- i. Type A earthing arrangement

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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 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,

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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 ²)
Aluminium	Solid type	70
	Solid round	50
Stainless steel	Solid tape	50
	Solid round	50

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 ²)
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.

- Equipotential bonding

All equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

- Bonding bar

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

A single bonding bar shall be installed for equipotential bonding. The bar shall be manufactured from electrical grade hard drawn aluminium 80sq mm complete with mounting insulators. The bar will be pre-drilled with ten M8 holes, fitted with stainless steel high tensile hex bolts with nuts and washers. The bar will be fitted with two removable test links, one on each end of the bar.

The bonding bar shall be connected to the earth-termination system at two connection points with two separate cables.

A ring bonding bar where more than one interconnected bonding bars are installed can be used for larger installations.

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.

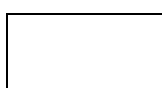
vii. Bonding conductors

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".

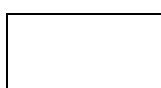
The following material and dimensions will be specifically applicable

Bonding components	Material	Cross-section (mm ²)
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

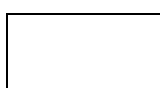
Table 2: Specific material and cross-section area for bonding components



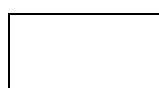
Contractor



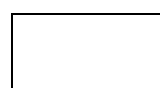
Witness 1



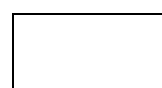
Witness 2



Employer



Witness 1



Witness 2

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

- The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- Increasing the contact resistance of the soil to above 100kΩ, or
- The down conductors are insulated against the lightning impulse (100 kV, 1, 2/50 μs impulse withstand voltage).

b) Step voltage

- The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- Increasing the contact resistance of the soil to above 100kΩ, or
- The down conductors are insulated against the lighting impulse (100 kV, 1,2/50 μs impulse withstand voltage), or
- 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).

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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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 Lightning Protection Zones (LPZ), where the first LPZ_n is the overall protection zone which borders the inner zone LPZ (LPZ_{n+1}). The effect of the LEMP is reduced with each zone employed. LPZ 0 is the unprotected outer zone where equipment will be exposed to full LEMP and lightning surge currents. LPZ 1...n is the inner zones where equipment is exposed to limited surge current and attenuated electromagnetic field. (Refer to SANS 62305-4 typical drawings.)

SPD's must be selected to reduce the surge overvoltage between the live conductors and earth to a value lower than the equipment's rated impulse withstand voltage U_w at its terminals (common mode withstand voltage). The type of SPD, the location of the SPD (as close as possible to the point of entrance of the line vs as close as possible to the equipment to be protected) as well as the connecting conductors must be considered.

e) Types of SPD's:

There are three types of SPD's:

- i. Type 1 SPD

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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 μ 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 μ 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 μ s) and current waves (8/20 μ 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

- 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 10mm².
- vi. The minimum cross-sectional area of the PE conductor for phase conductors 16mm² to 35mm² is 16mm².
- vii. The minimum cross-sectional area of the PE conductor for phase conductors above 35mm² is at least 50% of the phase cross-sectional area.
- viii. No mechanism (circuit breaker, disconnector, fuse or removable link) which can separate the neutral conductor from the neutral point may be installed.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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

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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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.

C3.10.21 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

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 – Heat resistant silicone rubber insulated flexible cable

3. Definitions and Abbreviations

The following definitions and abbreviations shall apply to this standard.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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.
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 2.5mm².

The minimum conductor size for power cables on plant equipment (excluding small power and lighting) shall be 16mm².

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 25mm². 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

The insulation material shall comprise of PVC in accordance with the requirements of the latest edition of SANS 1411.

c) Core Colour Identification

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.

The ends of the PVC sheathed cable shall be sealed to avoid penetration of moisture. Each cable drum shall be numbered.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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 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 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

Item

Unit

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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

C3.10.22 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

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;



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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.

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 mm², the cable core size from the junction box terminals to the socket outlet shall be 16mm², 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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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.

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

C3.10.23 EPS-08: ELECTRICAL MEDIUM VOLTAGE SWITCHGEAR

1. Scope

This specification covers the design, manufacture, test at works, supply, delivery, installation, test at site and commissioning of indoor metal-clad switchgear and associated equipment.

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 10142-2	:	The wiring of premises Part 1 – Low voltage installations
SANS 62271-1	:	High-voltage switchgear and controlgear Part 1: Common specifications for alternating current switchgear and controlgear
SANS 62271-200	:	High-voltage switchgear and controlgear Part 200: AC metal enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
SANS 62271-103	:	High-voltage switchgear and controlgear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
SANS 62271-100	:	High-voltage switchgear and controlgear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
SANS 62271-102	:	High-voltage switchgear and controlgear Part 102: Alternating current disconnectors and earthing switches
SANS 62271-105	:	High-voltage switchgear and controlgear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
SANS 62271-107	:	High-voltage switchgear and controlgear Part 107: Alternating current fused circuit-switchers for rated voltages above 1 kV up to and including 52 kV
SANS 62271-206	:	High-voltage switchgear and controlgear Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV
SANS 60282-1	:	High-voltage fuses Part 1: Current-limiting fuses
SANS 60529	:	Degrees of protection provided by enclosures (IP Code)
SANS 60044-8	:	Instrument transformers Part 8: Electronic current transformers
SANS 61869-2	:	Instrument transformers Part 2: Additional requirements for current transformers
SANS 61869-3	:	Instrument transformers Part 3: Additional requirements for inductive voltage transformers
IEC 62271-1	:	High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear
IEC 60255	:	Measuring relays and protection equipment



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.

4. Service Conditions

Nominal Voltage	6.6kV
Rupturing Capacity	20kA
Impulse level	95kV
Highest system voltage	7.2kV
Rated short-time withstand current (A)	20kA (1 sec)
Frequency	50Hz
Phases	3

All switchgear and auxiliary equipment shall be designed to withstand the stresses of an unearthed system.

5. Extent of Work

The successful Tenderer will be responsible for the design, manufacture, test at works, delivery, off-loading and erection on site, test at site and putting into operation of the switchgear. The Contractor shall furthermore be responsible for checking all connections made by others and for commissioning the switchgear. All paintwork damaged during transport and/or erection and/or connecting up, etc., shall be made good to the satisfaction of the Engineer.

6. Switchgear Layout

The switchboard shall be designed as a continuous assembly in a straight line, capable of being extended at either end. The switchboard will be located in a totally enclosed, naturally ventilated chamber and shall be suitable for installation directly on a finished floor.

7. Cubicle Construction

a) General

All cubicles shall be of the totally enclosed, floor mounted type and shall be vermin proof and where possible dustproof. The cubicles shall have a minimum enclosure rating of IP 42 to SANS 60529.

Cubicles shall be designed so that it is possible to add additional panels to existing switchboards without undue difficulty.

b) Segregation of circuits

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Each circuit in a switchboard shall be provided with an individual cubicle so arranged that accidental contact with live parts in adjacent circuit cubicles is impossible.

It shall be possible to terminate the cables of any circuit without exposure to any live conductors of the same circuit while the busbars are energized.

c) **Doors**

Where doors are provided on circuit breaker switch cubicles, the doors shall be fitted with handles consisting of a push-button-and-handle combination with a spring-loaded latch or a rotary handle-and-catch combination. The closing mechanism shall be designed to draw the door closed. Flush mounted ring type handles or square key operated latches are not acceptable. Locking latches shall be padlockable.

Doors shall be suitably braced and stiffened to carry the weight of equipment installed in doors and to prevent warping.

Control panel doors shall be fitted with handle closing mechanisms as described above. Alternatively, captive knurled bolts designed to be screwed in by hand may be used.

Doors shall have stops to prevent overswing of the door when opening and to prevent interference with adjacent panels.

Doors shall be fitted with suitable rubber or synthetic rubber seals.

All doors shall be bonded to the framework by a braided copper earth strap.

8. Circuit Breakers

a) **General Construction**

Circuit breakers may be of the trip-free, double break, SF6 or vacuum type.

Circuit breakers shall be of the horizontal draw-out truck mounted type with either vertical or horizontal isolation action.

Each circuit breaker shall be installed in a freestanding metal clad cubicle and the front of each panel shall be totally enclosed.

It shall be possible to remove the circuit breakers from the cubicles without moving the cubicle, without removing parts thereof or without disconnecting any wiring thereto.

Any circuit breaker shall be interchangeable with any other panel of the board of the same rating. It shall not be possible to insert a circuit breaker into a higher rated circuit.

Contact spouts, bushings, covers, busbar insulators, etc. shall be designed to minimise dust collection.

Mechanical stops shall be provided to ensure accurate location of the circuit breaker truck prior to racking into the service position. The breaker carriage shall be locked in position on both sides of the cubicle with a robust mechanical lock that will not distort or jam under fault conditions.

All openings, joints, etc., in the entire switchboard shall be adequately vermin proofed.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

All components including screws, nuts, bolts, washers, etc. used in the construction of or fixing of components shall be rendered corrosion proof.

b) Circuit breaking features

The circuit breaker contacts shall ensure rapid and consistent extinction of the arc with a minimum release of arc energy under all loading and fault conditions and a low power factor.

The arcing contacts shall be tipped or coated with an erosion resistant material, preferably a tungsten alloy.

The main contacts shall be self-aligning with a high contact pressure and a self-cleaning action.

c) Busbar and circuit shutters

Protective shutters, which automatically cover the contacts of the fixed portion of the switchgear when the circuit breaker is withdrawn to the isolation position, shall be provided.

The busbar orifices shall be provided with automatic separate shutters.

Facilities shall be provided for padlocking the shutters in the closed position.

All shutters shall close automatically after being opened by hand and it shall not be possible for the shutters or shutter operating links to be jammed by the circuit breaker.

Shutters shall be painted and designated as follows:

i. Busbar shutters

The word "BUSBAR" in black lettering on a red background.

- Circuit shutters

The word CABLE in black lettering on a yellow background.

- Earthing shutters

The word "EARTH" in black lettering on a green background.

- Lettering shall be a minimum of 40 mm high.

d) Interlocks

The switchgear shall be mechanically interlocked in accordance with SANS 62271 and all interlocks shall be robust and shall not distort or jam in the event of an incorrect operation. The minimum safety features provided shall prevent the following actions:

- A closed circuit breaker from being withdrawn from or inserted into the isolating contacts. The circuit breaker shall trip if an attempt is made to do so.
- The closing of the circuit breaker except when it is correctly located and fully racked in the "service" or "earthing" positions or in the fully lowered position. It must, however, be possible to close the circuit breaker when it is fully withdrawn from the cubicle.
- The lowering of the tank of circuit breakers unless the circuit breaker is fully withdrawn and the racking-in of the circuit breaker unless the tank is securely bolted in position.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- iv. The circuit breaker from being closed when the secondary circuits are not fully engaged. It shall also not be possible to remove the secondary circuit plugs unless the circuit breaker contacts are fully open.
- v. Electrical tripping of the circuit breaker when the circuit breaker is in the earthed position. Padlocking facilities shall also be provided to lock off the mechanical trip lever on the breaker mechanism.
- vi. The integral earthing switch (where applicable) from closing unless the circuit breaker is in the correct earth position. It must not be possible to close the earth switch onto live busbars.

e) Secondary isolating contacts

The connections in the secondary circuit between the fixed and moving portions of the equipment shall be by means of self-aligning contacts. Robust guide pins or other approved guides shall engage before the contacts.

Circuit breaker auxiliary contracts for functions common to the various panel type specified, shall be wired to secondary isolating contacts in the same relative position on all panel types specified.

The secondary isolating contacts must be so arranged that when the circuit breaker is in the lowered or racked down position the secondary isolating contacts can still be made without the addition of separate jumper equipment.

f) Position stops

Immediately prior to racking in, positive stops shall be engaged to locate the circuit breaker in the correct position relative to the busbar selection guides or other approved means shall be provided to ensure accurate entry into the guides.

A positive stop shall be provided to ensure correct location without danger of "over-run" in the "racked in" position.

g) Earthing

Integral earthing facilities shall be provided.

Integral earthing facilities through the circuit breaker are preferred, but separate earthing devices or earthing switches mounted on separate trucks are acceptable.

Where separate earthing devices or earthing trucks are supplied, the gear shall be suitable for use on all the circuit breakers in a switchboard and shall also be suitable for earthing either the busbar or the cables. A full set of earthing devices or earthing trucks shall be supplied for each switchboard.

Earthing equipment shall have a making capacity and a rated short-time withstand current (I_k) equal to the rest of the switchboard.

h) Capacities and Fault Levels

The complete primary circuit (CB's, busbars, etc.) shall be capable of withstanding the rated short time withstand current.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The circuit breakers shall have continuous current ratings as specified in the Detail Technical Specification.

There shall be no audible corona discharge under working conditions. These requirements shall be taken to be complied with only if the audible corona extinction voltage is less than 9 kV to earth or 14 kV between phases.

Compliance may be conceded if it can be shown that any discharge below the specified levels takes place at points remote from all dielectric materials, and cannot cause their deterioration.

The switchgear shall have an assigned impulse rating of not less than 95 kV at sea level, supported by recent test certificates proving successful testing, using a standard 1/50 microsecond voltage wave, on identical units manufactured in the factory from which an order would be executed.

Circuit breaker tanks and top plates shall be capable of withstanding, without permanent distortion, a hydraulic pressure of 700kPA for 1 minute, unless a lower pressure is approved after reference to actual pressures measured during short circuit tests.

Each circuit breaker shall be clearly and indelibly marked to show the current and voltage ratings and breaking capacities.

i) Closing Mechanisms

The closing mechanism shall be either of the hand charged, spring or hand operated, spring assisted or motor wound spring charging or solenoid operated types as specified in the Detail Technical Specification.

The closing action of the hand operated, spring assisted mechanisms shall ensure that once closing is initiated the action becomes independent of the operator.

All mechanisms shall be of the trip-free type and it shall not be possible for the mechanism to maintain the circuit breaker in a "closed" position during fault conditions or when the "open" signal has been initiated.

The electrical closing circuitry shall be open circuited as soon as the closing sequence has been completed to prevent continued electrical loading of the closing circuitry and to deactivate the closing signal until a new sequence is initiated.

Where auto-reclosing duties are specified, the mechanisms shall be capable of performing a "BREAK-MAKE-BREAK" operation.

All electrically operated closing devices shall be at least suitable for operation at any voltage between 80% - 120% of the nominal control voltage at the device terminal. The nominal control voltages are specified in the Detail Technical Specification.

Anti-pumping devices shall be provided on all mechanisms to prevent pumping while the closing circuit remains energised and the circuit breaker either fails to latch or trip during closing due to the operation of the protection system. The arrangement shall be to the approval of the Engineer.

j) Tripping Mechanisms

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

A manual tripping mechanism shall be provided on each circuit breaker. It shall be clearly marked "MANUAL".

Where shunt tripping is specified DC shunt trip coils shall be provided. The rated control voltage shall be as specified in the Detail Technical Specification.

Shunt trip coils shall be suitable for operation at any voltage between 80% - 120% of the nominal voltage at the device terminals.

Secondary contacts operated by the circuit breaker mechanism shall be provided and rated to interrupt the maximum trip coil current after the circuit breaker has opened. These contacts shall close the tripping circuitry before the circuit breaker closes.

k) Racking Mechanisms

The racking mechanisms for inserting or withdrawing the circuit breaker shall be designed and constructed to provide a positive action throughout the operations.

l) Indicating devices

Each circuit breaker shall be equipped with mechanical indicators to indicate the switching positions and the state of the spring mechanisms (if applicable).

A mechanical indicator shall also be provided to indicate whether the circuit breaker is racked in or out.

All mechanical indicators shall be clearly visible from the front of the panel.

In all cases positive indication must be provided

m) Auxiliary Contacts

Circuit breakers shall be provided with sufficient auxiliary contacts to suit the circuits served.

Auxiliary contacts shall be positively driven in both directions and shall be readily accessible for maintenance and shall be properly adjusted where necessary.

At least two spare normally open and two spare normally closed contacts shall be provided and shall be completely wired to an accessible terminal block.

9. Non-Automatic Switches and Fused Switches

a) General

The switches shall be of the fault-making, load-breaking type with earthing and testing facilities. The switches shall be manufactured and tested in accordance with SANS 62271.

b) Construction

The switches shall be totally enclosed, metal-clad, air or SF6-insulated type.

The switch units shall be designed for extension with circuit breaker panels described in this specification and/or similar switch units.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Each unit shall be installed in a free-standing metal clad cubicle and the front of the cubicle shall be totally enclosed.

The switch may be either of the horizontal draw-out with vertical or horizontal isolation, or non-withdrawable fixed tank types.

c) Busbar and circuit shutters

Busbar and circuit shutters shall be provided on all withdrawable type switches as specified for circuit breakers

d) Interlocks

The mechanism shall be incapable of moving directly to the "EARTH" position from the "ON" position.

A time delay shall be built into the mechanism to prevent immediate opening of the switch after closure. This shall be achieved by means of non-reversible operating handles, mechanical sliding interlocking gates or a non-reversible movement.

Padlocking facilities shall be provided.

Access to the testing facilities shall only be possible with the switch in the "EARTH" position. With the testing devices fitted operation to either the "ON" or "OFF" positions shall be prevented.

Interlocks shall be provided on withdrawable type switches to prevent:

- The switch from being withdrawn from or inserted into the isolating contacts.
- The closing of the switch except when it is correctly located or fully withdrawn.
- The opening of the tank unless the switch is fully withdrawn and the racking-in of the switch unless the tank is securely fitted.

e) Operating Mechanism

The switch shall have three positions, namely "ON", "OFF" and "EARTH".

Except for removing the earth, the switch actuating mechanism shall have a positive action and shall be spring assisted to ensure that once the operation is initiated, it becomes completely independent of the operator.

The fused switch shall close fully when making onto a fault to ensure full clearance of the fault by the fuses before tripping and opening the switches.

A blown fuse on any of the three phases shall open all three phases of the switch and shall inhibit the closure of the switch pending fuse replacement.

f) Earthing

Integral cable earthing facilities shall be provided for non-withdrawable switch units. For withdrawable switches earthing facilities similar to that of circuit breakers shall be provided.

g) Cable Test Facilities

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Cable test facilities are required and must be easily accessible.

Refer to paragraph 8.4 regarding interlocking of test facilities.

In the event of a separate test unit being provided, it shall be easily fitted.

h) Ratings

The fault making capacities, impulse levels and busbar ratings shall be identical to the ratings of the circuit-breakers installed in the same switchboards.

The continuous current rating of a switch shall not be less than 400 A and that of a fused switch not less than 90 A.

Each unit shall be clearly marked to show the current and voltage ratings and fault making capacity.

i) Indicating Devices

Each switch shall be equipped with positive mechanical indicators to indicate the switching position and the racked mode (where applicable).

All indicators shall be visible from the front of the panel.

Potential indicator lights shall be provided to indicate the status of all three phases of the cable circuit.

j) Fuses

Fuses shall comply with SANS 60282-1

Fuse links shall be of the striker pin type, hermetically sealed and shall be suitable for use under oil.

The fuse link carriage shall be suitable to accept either 254 mm or 359 mm long fuses both with a diameter of 63,5 mm. The carriage shall be adjustable for this purpose and shall not necessitate additional parts.

Automatic shutters shall be provided to safeguard against inadvertent contact with live parts when the fuse carriage is removed.

The ratings of the fuses shall be as specified.

10. Busbars

a) Design and rating

Busbars shall be manufactured of solid drawn high conductivity copper with rectangular cross-section in accordance with BS 159, SANS 1195 and BS 13601, where applicable.

The busbars shall be rated for the continuous current carrying capacity specified in the Detail Technical Specification and the fault levels specified in paragraph 1.3. The busbars shall be designed to withstand mechanical and temperature stresses for normal and fault conditions taking into account correction factors for different configurations, "proximity and

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

skin" effects, the effect of ferrous enclosures, ventilation, etc. The maximum allowable temperature of busbars carrying full load at the specified ambient temperature is 80°C. Tables 1 and 2 may be used as a guide to determine the current rating of the busbars.

Table 1: Derating Factors for Laminated Busbars

Area of cross-section (mm)	Number of parallel busbars per phase		
	2	3	4
500	1,78	2,24	3.13
1000	1,72	2,36	3,00
1500	1,65	2,24	2,84
2000	1,60	2,16	2,70
2500	1,55	2,10	2,60
3000	1,52	2,02	2,52
3500	1,48	1,98	2,48
4000	1,44	1,96	2,45

Table 2: Current Rating of Single Copper Busbars (A)

Width (mm)	2,5	3,15	4,0	6,3	10	12,5	16
12,5	155	180					
16	190	220	250				
20	230	265	300				
25	280	320	365	470			
31,5	340	385	440	560			
40	420	475	540	680	870		
50	510	575	650	820	1030	1160	
63			790	990	1240	1370	
80			970	1200	1480	1640	
100			1160	1430	1760	2180	
125				1710	2100	2310	2570
160				2070	2530	2780	3090
200						3290	3660
250						3900	4300
315						4630	5120
400							6230

In additions to current rating busbars shall comply with the following fault level rating:

$$A = 8,2 \times I \times (t)$$

where:

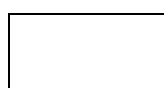
A = minimum cross section (mm)

I = prospective fault current (kA)

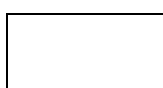
t = maximum time in seconds required for protection equipment to clear the fault.

(Minimum allowable value for t = 3s.)

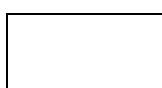
Where a busbar consists of two or more busbars per phase (laminations), the laminations shall be separated by a minimum distance of the thickness of one lamination. The laminations shall be clamped together with copper spacers at intervals not exceeding 450 mm in order to equalize the current distribution in the laminations.



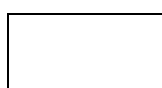
Contractor



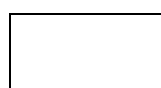
Witness 1



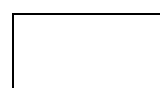
Witness 2



Employer



Witness 1



Witness 2

Busbars shall be able to carry the rated current along their entire length. Tapering is not permitted.

The manufacturer shall, where requested, provide design calculations of the busbar ratings

Busbars shall be as short and straight as possible.

Busbars shall be adequately ventilated and shall be situated in separate, totally enclosed, dust free, metal enclosures.

At each end of a switchboard a removable cover shall be fitted to the busbar chamber in order to extend the switchboard in both directions in the future.

The busbar ends shall be suitably manufactured and drilled for future extensions without modifications to the existing busbars.

b) Insulation and joints

All busbars and connections shall be air insulated and shall be shrouded with heat-shrinkable sleeving or shall be epoxy resin encapsulated. PVC taping, insulating compound or oil immersion is not acceptable. The colours shall correspond to the colour of the supply phase:

- Red, Yellow or White Phases
- Blue or Black Neutral

Busbar joints and tees shall be encased in a non-hardening compound and taped with PVC tape unless suitable shrouds are provided.

The complete primary system shall withstand the full power frequency test voltage specified by SANS 62271 and the insulations level of all busbars and connections shall be in accordance with the values specified in paragraph 8.3.

Where connections between busbars and any other part of the switchgear consist of bare copper conductors, and no other insulation except air exists between phases or phases and earth, the clearance distances and insulator lengths shall be in accordance with SANS 62271 with correction for altitude as required.

c) Earth busbar

An earth busbar shall be installed in a convenient position along the entire length of the switchboard. The cross-sectional area of earth busbars shall be calculated in accordance with the following formula in IEC 439 with a minimum cross-section of 6,3 x 20 mm:

$$S = I \times t / X(dT)$$

Where:

S	=	cross-section (mm)
I	=	the r.m.s. value of the current (A)
X	=	13 for Copper
t	=	operating time of protective equipment (s)



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

(Minimum value for $t = 3$ s)
 $dT =$ temperature rise ($^{\circ}\text{C}$)
 $=$ 120°C for insulated conductors
 $=$ 180°C for uninsulated conductors

If t is between 2 s and 5 s then dT may be increased in the same formula to:

$dT =$ 145°C for insulated conductors
 $=$ 215°C for uninsulated conductors

In addition, the longer side of the earth bar shall be at least twice the diameter of the largest bolt that will be fitted to the busbar.

11. Secondary Circuitry

a) Cabling

Gland plates, suitably drilled to accept the glands for all the external power, control protection and DC supply cables, shall be provided.

The internal wiring to be connected to the cabling mentioned above shall be terminated on numbered terminal strips in close proximity to the gland plate in order that the cable cores can be connected directly to the opposite sides of the terminal strips.

b) Wiring

All wiring shall present a neat appearance and shall be suitably braced, placed in wiring channels or clipped and/or laced.

Connections to equipment mounted on doors shall be arranged to give a twisting motion and not a bending motion to the conductors.

All panel and equipment terminals, labels, etc. shall be completely accessible after the wiring and cabling has been completed.

Conductors shall be identified at both ends by means of durable closed ring interlocking cable marking ferrules. PVC or other tape is not acceptable. The numbers on the markers shall also be shown on the wiring diagrams.

Where conductors are terminated on equipment terminals that do not require the use of lugs, the identification ferrules shall be fixed so that they do not fall off when disconnecting a conductor.

Identification ferrules shall read from the terminal along the wire.

All wiring terminating on meters, fuse holders and other equipment with screwed terminals, shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor. Secondary wiring shall generally consist of insulated stranded copper conductors with a minimum cross-sectional area of $2,5 \text{ mm}^2$. Solid core conductors are not acceptable. Flexible cords not smaller than $1,0 \text{ mm}$ shall be installed between equipment mounted on doors and the rest of the switchboard. For voltage ratings in excess of 50 V the wiring insulation shall withstand a test voltage of 2 kV to earth for one minute. For voltages of 50 V or less the insulation shall withstand 500 V to earth for one minute.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

All wiring between different panels within the same switchboard shall be installed in wiring channels. Grommets shall be installed in each hole in the metalwork through which conductors pass. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges. All wiring shall be installed away from terminals, clamps or other current carrying parts.

Conductors may be jointed at equipment terminals or numbered terminal strips only.

To minimize the effect of electrolysis, DC circuits shall be so arranged that the isolating or N/O operation contacts are connected to the positive pole of the battery.

c) Secondary terminals

All external wiring and connections to auxiliary contacts, all alarm, protection, intertripping, DC supply circuits, etc. shall terminate on numbered terminal strips. All numbers shall appear on the switchboard drawings.

Terminals of the type where clamping screws are in direct contact with the conductor are not acceptable.

Where stud type terminals are provided they shall have a minimum size of 0 B.A. Approximately 10% with a minimum of 2 spare terminals shall be provided on each terminal strip.

Terminal and test blocks of a reputable manufacturer, complying with the requirements of SANS 60947-7-1 shall be provided in each panel for the secondary wiring of the current transformers

12. Current Transformers

a) General

Current transformers shall comply with the requirements of SANS 60044-8 with the exception of the required impulse test level.

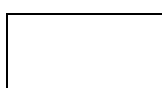
b) Ratings

Current transformers shall be suitable for the primary currents and secondary ratings as specified in the detail specification.

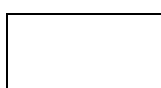
Current transformers shall have secondary outputs of 2.5, 5, 10, 15 or 30 VA as applicable in terms of the burden of the instruments and interconnecting wiring. The current transformer output shall match the actual instrument burden as closely as possible in order not to introduce unnecessary errors.

c) Accuracy Class

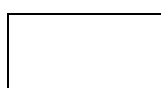
Application	Primary current	Class
Indicating instruments	All	5
Metering applications	Up to 200A	2
Metering applications	250A to 600A	0,5



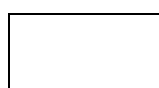
Contractor



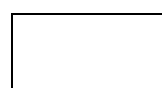
Witness 1



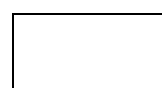
Witness 2



Employer



Witness 1



Witness 2

Metering applications	800A and above	0,2

For metering applications, accuracy classes of 0.1, 0.2, 0.5, 1, 3 or 5 are applicable. Where no accuracy class has been specified, the following table may be used as a guide:

Where ring type current transformers are specified, the aperture shall not be unnecessarily large as accuracy is thereby reduced.

The classes for protection are 5P, 10P, 15P, 20P or 30P with 5P and 10P being standard. Turns

compensation shall be employed on protection current transformers for ratios greater than 30/1.

Class X current transformers shall be used in differential protection systems.

Manufacturers shall supply the magnetization curve details and saturation factors for each different transformer ratio.

d) Markings

All current transformers shall come complete with a label on which the following information is indelibly stamped:

- Manufacturer
- Serial No. or Type
- Rated primary and secondary current
- Rated frequency
- Rated output and accuracy class
- Highest system voltage
- Rated insulation level

A duplicate of this label must be attached in a position which is clearly visible on the inside of the protection panel. The specific connections for both the high and low ratio's of a dual-ratio CT, must be clearly labelled at a visible position in the protection panel.

e) Fault Current

Current transformers shall be capable of withstanding the dynamic forces resulting from the maximum through-fault current which may be encountered at the point where they are installed. The short time current rating of current transformers shall be at least equal to that of the associated circuit-breaker.

f) Impulse Level

Current transformers used in system voltages in excess of 660 V shall withstand an impulse test level of 95 kV.

g) Tests

One protection current transformer of each type used in a contract shall be tested to confirm the estimated characteristics. The following results shall be submitted:

- Magnetization curve
- Secondary resistance
- Secondary leakage reactance, if not negligible or if required by the Engineer.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

The power frequency, secondary to earth and overvoltage interturn tests in accordance with BS 3938 shall be conducted on all current transformers. Impulse tests shall be conducted on all current transformers intended for use in system voltages in excess of 660 V.

13. Voltage Transformers

a) General

Voltage transformers shall comply with SANS 61869-1 and 3 where applicable.

The voltage transformers are of the epoxy resin insulated type and are used to supply measurement and protection devices. VT's can be installed as a fixed assembly or installed on removable and withdrawable trucks. Fixed voltage transformers can be installed directly on the main busbar system in a dedicated VT compartment. Withdrawable trucks must allow replacement of the fuses with the switchgear in service. The withdrawable truck arrangement must be fitted with automatic shutters between the live parts of the switchgear and the instrument compartment. The VT can have one pole (L-N) with a secondary voltage of $110/\sqrt{3}$ (63.5V) or two poles (L-L) in which case the secondary voltage shall be 110 V unless specified to the contrary.

b) Voltage Transformer Protection

The primary side of all voltage transformers shall be connected to the circuit through high voltage HRC fuses. Fixed VT installations will have external MV fuses and withdrawable VT installations will have internal MV fuses.

Secondary HRC fuses or protective circuit breakers shall be provided on the output terminals, located in the LV compartment.

c) Voltage Transformer Ratings and Tests

The voltage transformers shall have an output suitable for the connected load but at least 200 VA per phase at class B accuracy.

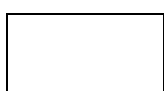
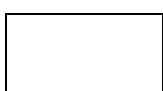
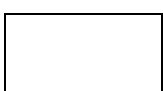
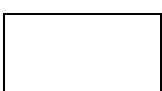
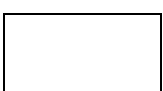
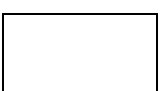
The voltage ratios shall be suitable for the primary busbar and the required output voltages. Voltage transformers shall be tested in accordance with BS 3941 and shall withstand an impulse level of 95 kV.

14. Current and Voltage Sensors

Current and voltage sensors shall comply with SANS 61869.

- a) IEC 61869-10: Instrument transformers - Part 10: Additional requirements for low-power passive current transformers.
- b) IEC 61869-11: Additional requirements for low power passive voltage transformers

Current and voltage sensors are designed without the use of a ferromagnetic core. The current sensor is based on the principle of Rogowski coil. Voltage sensor uses the principle of resistive voltage divider. The main benefit is that the behaviour of the sensor is not influenced by magnetizing curve that results in a highly accurate and linear response across a wide dynamic range of measured quantities. The linear and highly accurate characteristic curve of the sensor across its full operating range enables several metering and protection classes to be combined in one particular winding.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

15. Protection Relays

Protection relays shall comply with IEC 60255: Measuring relays and protection equipment.

Digital protection relays which use a microprocessor to analyse power system voltages, currents or other electrical quantities for the purpose of detection of faults in an electric power system will be supplied. The characteristics and behaviour of the protection relay must be programmed to requirements. The protection relay must offer multifunctional protection (overcurrent and earth-fault as a minimum).

The protection relay should offer the following features:

- a) Self-checking facility;
- b) Local HMI display with basic system parameters shown;
- c) Low burden on current and voltage sensors;
- d) Communication port for the connection to a LAN;
- e) Adaptive relaying schemes which can vary its setting parameters in response to changes in the power system;
- f) Storage of historical data with time stamping;
- g) Simple and easily maintainable

16. Instruments

- a) General Requirements

Instruments shall be suitably rated for the supply voltage and frequency to be applied, which shall be 400/230 V, 50 Hz unless specified to the contrary.

All the instruments used for a particular application or a specific project shall be from the range of a single reputable supplier and shall have the same face dimensions. The face dimensions shall be square and not less than 96 x 96 mm.

All instruments shall comply with IEC 60051-1.

Instruments shall be screened against magnetic interference and shall have anti-static against magnetic interference and shall have anti-static, impact-resistant faces.

Preference will be given to locally manufactured instruments.

Instruments shall be insulated to achieve a 2 kV insulation resistance to earth.

All instruments shall be splash proof and dustproof unless more stringent requirements are specified for hazardous locations

Instruments shall be sufficiently resistant to vibration that may be encountered in the specific application.

For normal environmental and supply conditions, instruments shall be suitable for use inside the limits specified in IEC 60051-1.

All instruments shall be capable of withstanding overloads of continuous or short duration in accordance with IEC 60051-1.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Instruments shall be provided with studs for rear connection. Shrouds shall be provided to prevent accidental contact where instruments are to be installed in hinged panels of switchboards.

b) Voltmeters and Voltmeter Selector Switches

Voltmeters shall be of the moving iron type with class 1,5 accuracy as specified in IEC 60051-1.

A zero adjustment screw shall be provided.

Unless specified to the contrary, a single voltmeter and selector switch shall be provided. The voltmeter switch shall have an "OFF" and three metering positions to indicate readings between neutral and each of the three phases.

The markings shall be indicated clearly on the face plate of the selector switch and the handle position shall be accurate in relation to the markings on the face plate.

The selector switch shall be of the cam-actuated or wiping air break type with two breaks per pole.

c) Ammeters

Ammeters shall have a moving iron element to indicate instantaneous values. Current transformer operated ammeters shall be 5 A full scale, calibrated to read actual primary circuit currents. The current transformer ratio shall be indicated on the faceplate. A zero adjustment screw shall be provided.

Where combined maximum demand and indicating ammeters are specified, a bimetallic spiral element shall be provided in the same housing to indicate mean value over a 15 minute period.

The bimetal element shall drive a residual pointer to indicate maximum mean current between resetting. This pointer shall operate on the main scale and shall be of a distinctive colour. The pointer shall be resettable from the face of the meter.

The bimetal element shall be designed to compensate for limits of ambient temperature between -20°C and 70°C.

Full load or rated current shall be clearly indicated, preferably with a red line. Unless specified to the contrary, a 100% condensed over scale shall be provided for instantaneous reading instruments and no over scale for combined maximum-demand ammeters.

The intrinsic error, expressed in terms of the fiducial value in accordance with IEC 60051-1, shall be class 1,5 for the instantaneous readings and class 2,5 for the mean maximal. Where saturation current transformers are required, these shall form an integral part of the meter. Separate saturation current transformers are unacceptable.

17. Auxiliary Equipment

a) Control Switches

Circuit-breaker closing and tripping control switches shall close the associated circuit breaker when rotated clockwise.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Control switches may be fitted with one pair of lazy contacts, i.e. contacts which make when the control switch is turned to the closed position, remain closed when the handle returns to the neutral position and only open when the control switch is moved to the trip position.

The switches shall be provided with a suitable faceplate indicating the angle of throw and the switching positions.

The switches shall be suitable for the supply voltage and the contacts shall be silver-plated or gold laminated and shall be suitably rated for the switching functions intended.

Control switches shall be lockable in the "NEUTRAL" or "OFF" position.

b) Fuses

All fuses for the protection of auxiliary circuits shall be of the high rupturing capacity cartridge type and shall be mounted on insulated draw-out carriers which shall hold the fuses positively after withdrawal.

The top terminal shall be the live terminal in all cases.

HRC fuses shall be provided in the positive leads of all DC circuits.

Fuses shall be so positioned that they are readily accessible to a person standing on the floor in front of the panel.

Labels shall be fitted adjacent to fuses stating their use, rating and duty.

c) Indicator Lamps

The following indications shall be provided:

Function	Colour
Circuit-breaker closed.....	Red
Circuit-breaker open	Green
Incoming supply available (on incoming panel only)	White
Auto-trip.....	Amber
Trip circuit healthy.....	White

A lamp test pushbutton for all the indicating lights shall be provided on each switchboard. The "trip circuit healthy" indication shall normally be off and a pushbutton shall be provided to indicate the status. The purpose of the indication is to ensure that the tripping voltage supply is available on the panel before the circuit-breaker is closed. An indicator light with pushbutton is required on each panel and one indication per switchboard is not sufficient. The circuitry shall be arranged to provide indication with the circuit breaker in both the "OPEN" and "CLOSED" positions.

The conditions indicated shall be designated below each light.

d) Voltage Indicator System

All switchgear will be fitted with a capacitive divider voltage indicator system (VDS) connected to the cable side of the switchgear. All systems supplied will permit phase comparison (with specialised measuring Units) All VDS's will comply with IEC 61243-5.

e) Instrument Test Blocks

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

For the purpose of connecting external test equipment or instruments in the secondary circuits of the current transformer or potential circuits, these circuits shall be wired via an approved test block mounted on each panel.

The test blocks shall be fitted with terminal strips and links for performing the various short circuiting and bridging functions.

f) Labels

Labels shall be made of durable material to approval. Metal labels where used shall be engraved or etched. Labels made of trifoliate or other similar materials shall have engraved lettering. Self-adhesive printed tape labels shall not be used. All labels shall be fixed mechanically.

18. Cable End Boxes

Cable end boxes to accept the cables specified for each panel shall be provided.

The boxes shall be of the metal clad type suitable for indoor use. These shall be equipped with armour clamps and brass or gunmetal conical wiping glands for lead covered steel tape or galvanized steel wire armoured, paper-insulated cables or XLPE galvanized steel wire armoured cables (as specified in the Detail Technical Specifications).

The cable boxes shall be fitted with insulating pieces to allow for the possible future installation of frame leakage busbar zone protection when specified in the Detail Technical Specifications. Cable boxes shall be so designed that cable terminal connections can be made below compound level.

19. Finish

The switchboards shall be finished with a high-quality paint applied according to the best available method. Baked enamel, electrostatically applied powder coating or similar proven methods shall be used.

20. Labels

Care shall be taken to ensure that all equipment is fully labelled.

Panel designation labels shall appear on the front and back of each panel and on the circuit breaker truck.

Engraved sandwiched interchangeable plastic or ivory strips shall be used throughout. The strips shall bear white lettering on a black background.

Labels shall be secured by means of brass bolts, nuts and washers. Where this is not practicable cadmium-plated self-tapping screws may be used. The gluing of labels will not be acceptable. Sufficient fixing screws shall be provided to prevent labels from warping.

21. Battery Tripping Unit

A battery tripping unit, suitable for connection to a 230 V, 50 Hz, single-phase ac supply shall be provided with each switchboard. The charger shall be metal-clad and shall be suitable for charging a Ni-Cad battery with voltage and capacity as specified in the detail specification. The charger shall be such that the change-over from trickle to boost charge is automatic. The tripping unit shall be supplied complete with fuses on the ac supply side and on the outgoing dc. side of the charger, an ammeter to indicate the charging current, a voltmeter with spring-loaded push buttons to indicate battery voltage and a circuit to test the state of battery charge.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

22. Tests

All component parts of the equipment shall be subject to type tests and routine tests in accordance with the relevant SANS, BSI or IEC standard specifications.
Circuit breakers shall be subjected to the following tests in accordance with IEC 62271-1, adjusted for atmospheric correction:

a) Type Tests

- Mechanical endurance
- Temperature rise
- Dielectric strength and impulse voltage
- Making and breaking capacity and short time current

b) Routine tests

- Power, frequency, voltage
- Resistance of the main circuit
- Mechanical operation.

c) On site tests

The equipment shall be tested on site after erection and prior to commissioning.

The following minimum tests shall be performed:

- i. Pressure tests on the primary and secondary circuits in accordance with IEC 62271-1.
- ii. Insulation resistance tests.
- iii. Primary injection tests.
- iv. Earth continuity and earth resistance tests.
- v. Operating tests.
- vi. Any other tests which may be required to ascertain the correct functioning of the equipment.

The contractor is to provide a schedule of tests to be done on site prior to commencement of manufacture for approval by the Engineer. This schedule must be ticked off prior to commissioning.

After putting the panel to service for a minimum 1 week, a thermal image must be scanned and analysed for any hot spots. The image should be presented as part of the Operations and Maintenance manual.

d) Test Certificates

Copies of type test certificates shall be submitted together with the tender.

Copies of test certificates of all other tests i.e. routine tests and on site tests shall be forwarded to the Engineer on completion of the tests.

e) Test Performance and Inspection

The Engineer shall be notified in writing at least two weeks in advance of any tests to be conducted to allow its representative to be present at such tests.

The Engineer shall also be notified timeously of the completion of the equipment in order that an inspection may be carried out prior to delivery.

23. Tools and Auxiliary Equipment

The following equipment shall be provided with each switchboard and the cost shall be included in the tender price:

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- a) One raising and lowering handle for every three circuit breakers.
- b) One complete set of special maintenance tools for all sizes of circuit breakers.
- c) A full set of earthing devices or earthing trucks.
- d) One wall mounted steel box for the storage of the above loose equipment. The door shall be padlockable.
- e) At least six spare HRC fuses of each rating for secondary circuits and three high voltage HRC fuses for the voltage transformer.
- f) One cable test unit for each size circuit breaker or oil switch housed in a wall-mountable metal box.

24. Technical Information

Tenderers shall submit descriptive literature of the equipment with their tenders.

Three copies of erection, operating and maintenance instruction manuals covering each type of equipment shall be provided with each switchboard.

25. Drawings and Diagrams

- a) Drawings for Approval
 A set of three prints of the following drawings shall be submitted to the Engineer for approval.
 - General arrangement drawings
 - Detailed dimensional drawings
 - Schematic diagrams
 - Wiring diagrams
 - Foundation drawings.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the switchboards according to the requirements of this Specification.

- b) Final drawings
 On completion, a complete set of final transparent drawings shall be delivered to the Engineer.
 These drawings shall include the following:
 - i. An accurate "as built" wiring diagram of the complete installation showing circuit numbers, terminal strip numbers, conductor colours and numbers, etc
 - ii. A schematic diagram clearly showing the functions of all equipment.
 - iii. An equipment schedule showing the make, model and characteristics of all components used, including a recommended spare list.
 - iv. Fully dimensioned "as built" physical layout of the panel.

26. Completion

The contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the Engineer

27. Measurement and Payment

<u>Item</u>	<u>Unit</u>
Supply medium-voltage circuit breaker panel	no

The unit of measurement shall be the number of panels supplied.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.10.24 EPS-09: ELECTRICAL MEDIUM VOLTAGE ADJUSTABLE FREQUENCY / SPEED DRIVES RATED 300 – 10,000HP

1. Scope

The scope of work includes the furnishing of all labour, material and services for the design, manufacture testing at works, supply, delivery, installation, test at site and commission inspections at works, and rectification of defects developing during the warranty period.

c. Work to be included

- i. Adjustable 6.6kV 50Hz VFDs/VSDs configured for new MV squirrel cage induction motors to be installed in LNW 's Olifantspoort Pump Stations (PS1, PS2, PS3) and Ebenezer Pump Station as detailed below

Water Scheme	Pump Station	Pump	Motor Voltage (kV)	Motor Size (kW)	MV (6.6kV) VFD/VSD Size
Olifantspoort	Pump Station 1	Pump 1	6.6kV	1700 kW	1700kW/2280HP
		Pump 2	6.6kV	1700 kW	1700kW/2280HP
		Pump 3	6.6kV	1700 kW	1700kW/2280HP
		Pump 4	6.6kV	1700 kW	1700kW/2280HP
		Pump 5	6.6kV	1700 kW	1700kW/2280HP
	Pump Station 2	Pump 1	6.6kV	1700 kW	1700kW/2280HP
		Pump 2	6.6kV	1700 kW	1700kW/2280HP
		Pump 3	6.6kV	1700 kW	1700kW/2280HP
	Pump Station 3	Pump 1	6.6kV	1700 kW	1700kW/2280HP
		Pump 2	6.6kV	1700 kW	1700kW/2280HP
		Pump3	6.6kV	1700 kW	1700kW/2280HP
Ebenezer	Pump Station	Pump1	6.6kV	1100kW	1100kW/1475HP
		Pump 2	6.6kV	1100kW	1100kW/1475HP
		Pump 3	6.6kV	1100kW	1100kW/1475HP
		Pump 4	6.6kV	1100kW	1100kW/1475HP

- ii. The VFD/VSD shall be air-cooled
- iii. The VFD/VSD system must:
- iv. Represent a fully integrated package. Any components not manufactured by the VFD/VSD manufacturer shall be purchased by the VFD/VSD manufacturer and supplied with the VFD/VSD.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- v. Include all material and labour necessary to interconnect any VFD/VSD system element, even if shipped separately
- vi. Any modification to a standard product provided to meet this specification shall be performed by the VFD/VSD manufacturer only
- vii. The VFD/VSD system shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD/VSD manufacturer, to ensure properly coordinated, fully integrated drive system
- viii. Any third-party certification, safety or protection requirements shall be applied to the VFD/VSD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
- ix. The following equipment shall be furnished and installed as indicated
 - o Main power supply to VFD/VSD from existing 6.6kV Switchgear shall be installed by the Contractor
 - o Main power supply from VFD/VSD to 6.6kV High Lift Pump Motors shall be installed by the Contractor
 - o All external control cabling shall be installed by the Contractor
 - o Internal auxiliary and control power supplies shall be derived as specified in the VFD/VSD by the Manufacturer
 - o If the Manufacturer cannot meet this requirement due to specific drive design, Manufacturer shall explicitly provide this requirement to the installing Contractor at time of equipment bid and details for external supply requirements shall be provided and included in the submittal documents.
 - o Supervision of installation and commissioning of VSD/VFD

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
- SANS1874:2015 - Switchgear-Metal-enclosed
/ NRS 006:2013
- IEC 60076 - Power Transformers
- IEC 61131-3 - Programmable Controllers Part 3: Programming languages

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- IEC 61800-3 - Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods
- IEC 61800-4 - Adjustable speed electrical power drive systems – Part 4: General requirements – Rating specifications of a.c. power drive systems above 1000VAC and not exceeding 35kVAC
- IEC 60076-11 - Power transformer – Part 11: Dry-type transformers
- IEEE 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- IEEE 1100 - Powering and Grounding Sensitive Electronic Equipment -

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.

3. 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
- OWS - Olifantspoort Water Scheme
- 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
- CPU - Central Processing Unit
- DI - Digital Input
- DO - Digital Output
- FBD - Functional Block Diagram
- FAT - Factory Acceptance Test
- FDS - Functional Design Specification
- HMI - Human Machine Interface
- I/O - Input/Output
- PLC - Programmable Logic Controller
- SCADA - Supervisory Control and Data Acquisition
- SAT - Site Acceptance Test
- UPS - Uninterrupted Power Supply
- VFD/VSD - Variable Frequency/Speed Drive
- PMW - Pulse Width Modulation is a method of controlling power devices to covert voltage levels. PWM is a popular method of control for converting DC voltage to AC voltage



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- IGBT - Insulated Gate Bipolar Transistor is a high-speed electrical switching power device. It is very efficient requiring very low power for control circuits
- HCT - Hall effect Current Transformer is used for current detection of DC to high frequency without direct contact or shunt
- CPT - Control Power Transformer is typically used to power control circuits and relays for the VSD/VFD
- LCD - Liquid Crystal Display is a device used for displaying of alpha-numeric or graphical characters. It is in the operator interface of the VSD/VFD

4. System Description

i. VSD/VFD Components

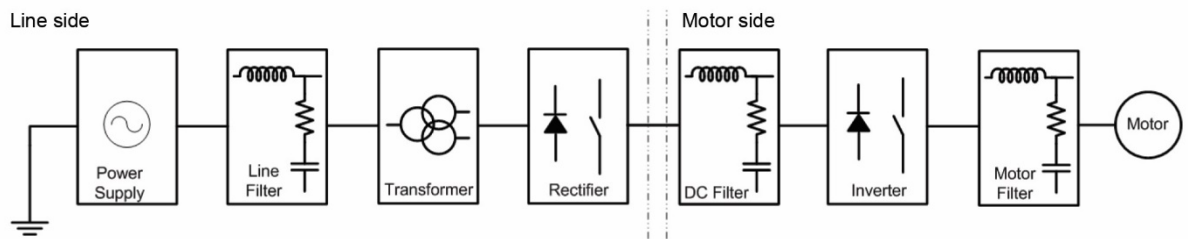


Fig 1: VSD/VFD Functional Block Diagram

c. Line Side

- Main Incoming Power Supply
 - Nominal Voltage: 6600V (6.6kV), 3-phase, 50Hz. A single main feed will be provided for each VFD/VSD
 - Maximum fault level: 25kA
- Existing metal Clad Switchgear
 - System input protection
 - Electrically interlocked with VFD/VSD
 - Existing Metal clad switchgear with vacuum Circuit breaker to be used with basic open/close/trip signals and feedback
- Line Filter (if required)
- Phase Shift Transformer
 - Provide manufacturer's standard multi-pulse phase shifting transformer (24-pulse minimum)
 - Transformer shall be installed integrally to the drive enclosure. Include all fuses, cabling, and vibration dampening required
 - Transformer shall be dry-type, be K-rated for use with high harmonic power systems, and include electrostatic shielding between the windings
- Rectifier Section



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- Diode bridge with required protection
- d. **Motor Side**
 - DC Bus/Filter Section
 - Capacitors
 - Long-life film-type capacitors shall be preferred
 - Electrolytic capacitor designs will be considered. Storage and maintenance requirements related to the capacitor shall be explicitly stated in the submittal documents
 - Designs incorporating pre-charge circuits for limiting transformer inrush and peak diode current shall be preferred
 - Drive input contactor operating restrictions (operations per day, control/interlock requirements) shall be explicitly stated in the submittal documents
 - Inverter Section
 - Modular multi-level converter or modular cascaded H-bridge topology with PWM operation producing

j. **Requirements**

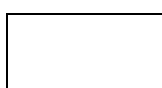
- **General**

Nothing in this standard shall lessen the obligation of the manufacturer and/or contractor. The manufacturer and/or contractor shall be fully responsible for the design testing, maintenance, repairs and refurbishment of the MV electric motors and its satisfactory performance in service. Approval by SMMMS/LNW shall not relieve the contractor of the responsibility for the adequacy of the maintenance, repairs and refurbishment.
- **Service Conditions**

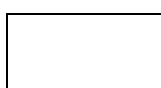
The requirements in this specification apply to transformer for use under the following general condition in Table 1.

Table 1: Atmospheric Conditions

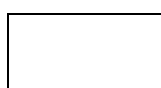
Environment	Limits
Application	Outdoors
Altitude	The design shall be based on an altitude of 1800m a.m.s.l
Maximum ambient air temperature	Hottest anytime 40°C Hottest monthly average 30°C



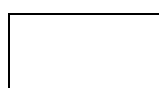
Contractor



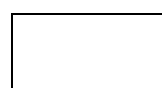
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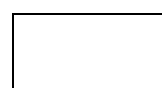
Witness 2



Employer



Witness 1



Witness 2

Yearly average ambient air temperature	20°C
Minimum ambient air temperature	Coldest anytime -10°C
Variation in humidity	10% to 90%

Data Sheet for MV Variable Frequency Drives Part 1 (Purchaser Requirements)

Basic Requirement	
Torque requirement	As per attached motor data sheet and speed-torque curve
Load/driven equipment	Centrifugal pumps details
Load torque details	Centrifugal pump as per attached data sheet and speed-torque curve
Drive system	1 Drive for 1 pump
Reacceleration of motor	As per Operational requirements
Motor to be used for drive	1700kW, 6.6kV 1100kW, 6.6kW
Input Power Supply System Condition	
No. of phases	Three
AC Input voltage	6.6 kV
Voltage fluctuations	±15%
Voltage unbalance	±15%
Rated frequency	50Hz
Frequency fluctuations	±5%
System fault level	25 kA (1 sec.)
System Requirements (Vendor shall furnish a separate datasheet for Variable Speed frequency system offered)	
Speed range required	10 – 100%
Speed reference signal	4 – 20mA / 0 – 10V
Operation in case of loss of	Last speed reference / A set speed reference signal lower than previous reference / either of the above as per manufacturer's standard
Acceleration time	During detailed engineering
Deceleration time	During detailed engineering
Communication facility	Required, integration with existing SCADA and PLC between Owner's control system and drive



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

Harmonic study	Required
Braking	Flux braking / DC injection braking / Either of the above
Converter transformer	Panel mounted Dry-type
Output voltage of VFD / VSD	6.6kV, Three-phase, Load / VFD/VSD side system in. 11 level (phase to neutral) PWM true sine wave output
Power factor improvement	Vendor shall ensure that converter design is such that minimum power factor at point of VFD/VSD is 0.97 regardless of speed and load
Efficiency at nominal power	>96.0% at 100% kVA load
Output surge arrestor	Required
Temperature measurement	Required for power cell cubicle
Synchronous bypass	Not mandatory
Dry type Transformer	
HT surge arrestor	Distribution class arrestor on transformer primary side to protect for HT surge
Short circuit protection	Short Circuit Protection for transformer secondary windings
Temperature measurement	Transformer winding temperature measurement & excessive heat loss measurement
Overload protection	Transformer overload protection
Impulse voltage withstand	Type test as per IEC 60076-11 to be performed
Heat run test	To be performed for 8 hours at rated capacity
Shielded isolation	Required between HV and LV winding
Control Locations	
Auto / Manual operation	Required
Auto / Manual selector	At panel / at remote process control panel switch location
Local / Remote operation	Required for controls
Local / remote selector	At panel / at remote process location control panel switch
Speed raise / lower signal	At VFD/VSD panel / At remote control room / At local control station
Separate reset button for alarm and fault	Specific requirement
Torsional Analysis	Required
Distance of Converter Panel From Drive Motor	Up to 1000m
On Communication Network (Compatible Modbus – TCP/IP Network Protocol0 the following Details Shall be Available	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Protection features	Yes
Indication	Yes
Metering	Yes
Diagnostic	Yes (Local, Remote: on TCP/IP)
Panel Enclosure	IP42, Min Thickness 2.0mm

5. Tests

All component parts of the equipment shall be subject to type tests and routine tests in accordance with the relevant SANS, BSI or IEC standard specifications.

Circuit breakers shall be subjected to the following tests in accordance with IEC 62271-1, adjusted for atmospheric correction:

- a) Type Tests
 - Mechanical endurance
 - Temperature rise
 - Dielectric strength and impulse voltage
 - Making and breaking capacity and short time current
- b) Routine tests
 - Power, frequency, voltage
 - Resistance of the main circuit
- c) On site tests
The equipment shall be tested on site after erection and prior to commissioning.

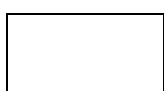
The following minimum tests shall be performed:

- i. Pressure tests on the primary and secondary circuits in accordance with IEC 62271-1.
- ii. Insulation resistance tests.
- iii. Primary injection tests.
- iv. Earth continuity and earth resistance tests.
- v. Operating tests.
- vi. Any other tests which may be required to ascertain the correct functioning of the equipment.

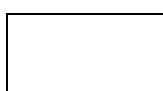
The contractor is to provide a schedule of tests to be done on site prior to commencement of manufacture for approval by the Engineer. This schedule must be ticked off prior to commissioning.

After putting the VFD/VSD to service for a minimum 1 week, a thermal image must be scanned and analysed for any hot spots. The image should be presented as part of the Operations and Maintenance manual.

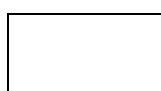
- d) Test Certificates
Copies of type test certificates shall be submitted together with the tender.



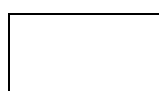
Contractor



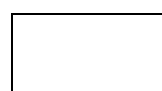
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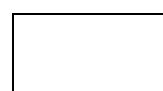
Witness 2



Employer



Witness 1



Witness 2

Copies of test certificates of all other tests i.e. routine tests and on site tests shall be forwarded to the Engineer on completion of the tests.

e) **Test Performance and Inspection**

The Engineer shall be notified in writing at least two weeks in advance of any tests to be conducted to allow its representative to be present at such tests.

The Engineer shall also be notified timeously of the completion of the equipment in order that an inspection may be carried out prior to delivery.

6. Tools and Auxiliary Equipment

The following equipment shall be provided with each switchboard and the cost shall be included in the tender price:

- a) One complete set of special maintenance tools for all VFDs/VSDs.
- b) A full set of earthing devices or earthing trucks.

7. Technical Information

Tenderers shall submit descriptive literature of the equipment with their tenders.

Three copies of erection, operating and maintenance instruction manuals covering each type of equipment shall be provided with each VFD/VSD

8. Drawings and Diagrams

a) **Drawings for Approval**

A set of three prints of the following drawings shall be submitted to the Engineer for approval.

- i. General arrangement drawings
- ii. Detailed dimensional drawings
- iii. Schematic diagrams
- iv. Wiring diagrams
- v. Foundation drawings.

The approval of drawings shall not relieve the Contractor of his responsibility to the Engineer to supply the switchboards according to the requirements of this Specification.

b) **Final drawings**

On completion, a complete set of final transparent drawings shall be delivered to the Engineer. These drawings shall include the following:

- i. An accurate "as built" wiring diagram of the complete installation showing circuit numbers, terminal strip numbers, conductor colours and numbers, etc
- ii. A schematic diagram clearly showing the functions of all equipment.
- iii. An equipment schedule showing the make, model and characteristics of all components used, including a recommended spare list.
- iv. Fully dimensioned "as built" physical layout of the VFD/VSD.

9. Completion

The contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the Engineer

10. Measurement and Payment

<u>Item</u>	<u>Unit</u>

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Supply Variable Frequency/Speed Drive. no

The unit of measurement shall be the number of VFD/VSD supplied
The tendered rate shall include full compensation for the supply and delivery of the VFD/VSD complete as specified in the detailed specification..

<u>Item</u>	<u>Unit</u>
Install Variable Frequency/Speed Drive. no	

The unit of measurement shall be the number of VFD/VSD installed
The tendered rate shall include full compensation for the installation of the VFD/VSD complete as specified in the detailed specification..

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PART 2: TECHNICAL DATA FROM MANUFACTURER

1	Manufacturer's Model reference no.	
2	Rating of drive panel	
a.	Output in amperes	A
b.	Rating expressed at (torque)	Constant torque Squared torque
c.	Rating declared at 45°C	
d.	Standard Rating	Design at °C
e.	Switching frequency at declared rating	Hz
3	Applicable code / standards	
4	Drive type	Flux vector control / Direct torque control / Mixed
5	Speed range	_____ % to _____ % of rated motor speed
6	Speed reference signal type	4 – 20mA / 0-10V
7	Input power supply ratings	
a.	Voltage	±
b.	Voltage % unbalance	±
c.	Frequency	±
8	Output voltage at -15% input voltage full speed, full load	
9	Overload capability of converter	
a.	115% in for	min
b.	150% in for	min
c.	Inrush current 250% in for	sec

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

10	Overall efficiency of drive (excl. motor) at	
a.	100% kVA Load	
b.	75% kVA Load (shall be used for comparative evaluation purpose)	
c.	50% kVA Load	
d.	25% kVA Load	
11	Individual efficiency of rectifier at output DC link Individual efficiency of Inverter	
12	Overall power factor of drive (excl. motor) at	
a.	100% Load	
b.	75% Load	
c.	50% Load	
d.	25% Load	
13	AC Output	
a.	Rated frequency range	
b.	Accuracy of frequency	
14	Dynamic response	
a.	Speed fluctuation band	
b.	Speed recovery time after 100% torque step	
15	Transient Torque	
a.	Max. Transient air gap torque/duration	
b.	Max. Transient air gap torque/duration	
16	Wave form distortion factor (% harmonics) in output/input (V & I) waveform (Number of harmonics generated shall be furnished)	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

17	Output short cct. Capability and duration		
18	Suitability to Motor		
a.	Suitable for kW rating/frame size		
b.	Deration required to motor frame/kW due to operation with electronic drive		
c.	Permissible No. of starts of motor Uniformly distributed in one hour HOT COLD		
d.	Type of Motor	Squirrel cage induction motor	
19	CONTROLS (Please answer as provided / not provided)	At PLC/SCADA	At Drive
a.	System Start		
b.	System Stop		
c.	System raise		
d.	System lower		
e.	Drive frequency setting		
f.	Jog mode		
g.	Dynamic brake		
h.	Remote breaker trip		
i.	Electronic ramp function		
j.	Speed & current controller		
k.	Drive ready to start signal		
l.	Ammeter		
m.	Speed indicator		
20	Diodes / IGBT Configuration		

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

21	Total No. of Diodes / IGBT Total no. of cells	
22	Cooling System	
a.	Type	
b.	Online Redundancy	
23	Speed control accuracy	
24	List of controls provide At the front panel (As per specification)	Yes / No
25	List of status measuring devices provided at provide (As per specification)	Yes / No
26	Type of Electronic Card mounting arrangement	Yes / No
27	Dimension	
a.	Length	
b.	Height	
c.	Depth	
d.	Weight of Cubicle	
(Dimensional details of all panels shall be furnished along with offer for substation sizing)		
28	Degree of protection for enclosure	
29	Paint shade	
30	Heat output of Panel and Air condition Tonnage requirement	
31	Whether Air Conditioning is required for these panels	
32	Control Supply voltage and Aux. Power requirement	
33	Main converter transformer	Dry type panel mounted and suitable for locating indoor along with VFD/VSD
a.	Make	
b.	Type of transformer	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

c.	kVA rating	
d.	Voltage rating	
e.	Vector group	
f.	Impedance	
g.	Overall dimension	
h.	Transformer accessories	
i.	Lightning Impulse Voltage	
34	DC Reactor / AC Line Reactor	
a.	Make	
b.	Type	
c.	Rating	
d.	Type of cooling	
e.	Overall dimensions	
f.	Heat output	
g.	Inductance of the reactor	
h.	Air core / Iron core	
35	Local control panel / station required as per spec	Yes / No
36	Manufacturing and Supply location	
37	Year and location of 1 st manufacturing of latest designed model of offered VFD / VSD	
38	Reactor Filter at O/P to reduce dv/dt at motor terminal	
39	MTBF of product	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

40	Noise Level	
41	Delivery period	
42	No. of pulse level and voltage input cell Output pulse / stages level (Ph to Neutral and Ph to Ph) No pf power cell provided in drive	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.25 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.

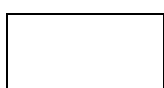
The Tenderer has to complete all required returnable schedules. Failure to comply with this request will lead to immediate disqualification.

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.

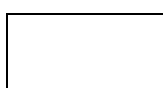
1.5 Normative References

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

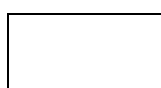
OHS Act 85 of 1993	:	Occupational Health and Safety Act, Act No. 85 of 1993
SANS 10142-1	:	Code of Practice for Wiring of Premises – Part 1: Low Voltage Installations (Edition 3:2020)
SANS 60439	:	Low Voltage Switchgear and Control Gear Assemblies
SANS 60947/IEC 947	:	Low-voltage switchgear and controlgear
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
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



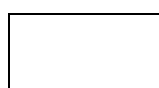
Contractor



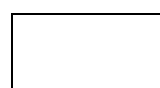
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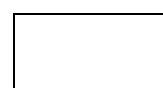
Witness 2



Employer



Witness 1



Witness 2

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
- All Single Online Double Conversion Static UPS Units will be continuous duty single or three phase units.
 - 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.
 - The UPS must employ PWM technology.
 - The UPS must have battery backup for at least 30 minutes at the full rated load of the UPS.
 - The output waveform shall be sinusoidal in form with the THD at full line load not exceeding 3%.
 - The output voltage variation must not exceed 2%.
 - Interference shall not exceed the limits laid down by ICASA
 - The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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,
 - Output Isolation Transformer,
- b) UPS Rating
- i. 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.
- ii. The UPS efficiency must be no less than 89% from zero to full load.
- iii. 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
- i. Tenderers must state the exact number of batteries that will be used.
- ii. Tenderers must state the type of batteries that will be used.
- iii. Tenderers must state the Ah rating of the batteries that will be used.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- iv. 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:-
- 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.
 - 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.
 - 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.
 - Bypass:
 - No-break transfer to and from Bypass mode shall be capable of being initiated manually, without operation of the static switch
- 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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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:

- 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)	

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. "Yes, full compliance" or "No".	
Tenderer to provide complete factory load test that can be witnessed by the Engineer	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

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 whom 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,

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

tests and results of the SAT must be available for signing by the engineer at the completion of the SAT.

- g) 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

- a) Packing
 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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

C3.10.26 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 H₂O
Vacuum - kPa (abs)

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Temperatures - °C
Flow (all gases) - m³ /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/m³

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.

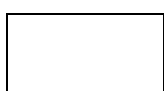
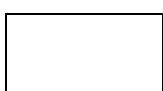
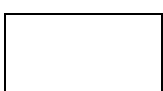
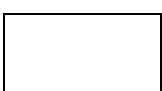
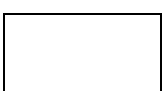
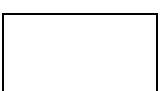
2.3 Indicators

- 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.

Each alarm system shall be equipped with flasher and horn and shall have provision for pushbuttons to acknowledge, reset and test the system.

					
Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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:

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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:

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

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:

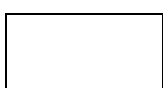
Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Standard materials that are suitable for process and ambient conditions shall be used.
Adjustment:	Independent for span and zero. (Adjustment may be via bus or handheld calibrator)

3.7 Radar Level

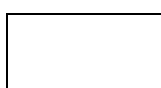
Microwave level measurement. Measures the transit time of a radar signal that is reflected from the surface of a liquid.

Transmitter shall meet the following minimum requirements:

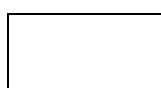
Accuracy:	1% of span or better
Repeatability:	0.2% of span



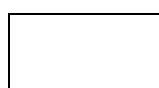
Contractor



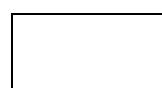
Witness 1



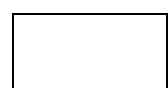
Witness 2



Employer



Witness 1



Witness 2

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)

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)

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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 for horizontal or vertical support
Case:		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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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

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	
Contractor	Witness 1	Witness 2	Employer

	°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 use.

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.

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

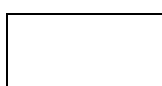
Filled systems shall not be used unless otherwise specified.

6. INDICATOR DESIGN

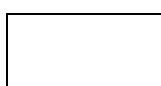
6.1 Flow Indicators

Flow indicator shall be rotameter or differential pressure type.

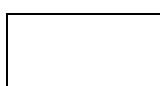
Rotameters, when used, shall preferably be of metal type with magnetic indicator extension. Glass type rotameters shall be used for purge or auxiliary services.



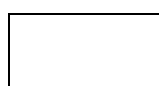
Contractor



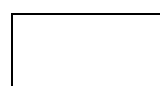
Witness 1



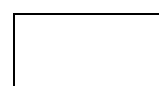
Witness 2



Employer



Witness 1



Witness 2

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. 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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 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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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.

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:

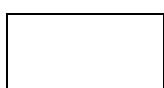
No, NC or change-over: 10A at 30V AC, 5A at 250V AC 5A at 30V DC, 0,4V at 250V DC

Mechanical lifetime: ± 106 cycles Suitable for ambient temperature -20 to +80°C

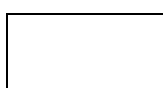
Electronic position indicator:

Supply voltage: 15 to 30V smoothed

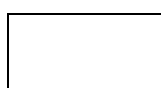
Output: 4-20 mA load R: 500 ohm at 15V, 1250-ohm max. at 30V



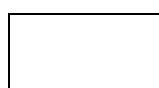
Contractor



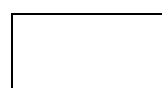
Witness 1



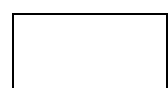
Witness 2



Employer



Witness 1



Witness 2

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		

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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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 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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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.

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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

9.3 Conductivity Measurement

Cell electrode material shall be carbide lined high grade steel or platinum black coated nickel and the cell range 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 μ 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 % O₂
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.

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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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

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

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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

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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

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.

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.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

C3.10.27 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

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

and/or motorised operation which is specified.

- Equipment which is controlled automatically shall be provided with protections against damage during start 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.

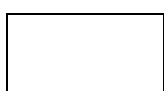
7. Systems with PLC / SCADA Control

7.1 Design

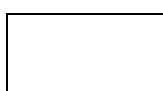
Control systems utilising PLC/SCADA systems shall be configured so that the installation will be able to operate under PLC control following a failure of the SCADA system.

7.2 Mimics

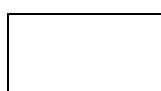
- Mimic screens provided for SCADA systems shall include the following:
- Overview; including the process flow diagram and indicating all electronically monitored parameters which are not included in a sub-system.
- Overview of each plant grouping.



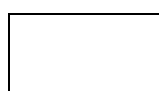
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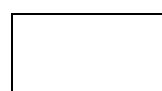
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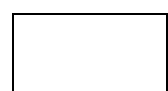
Witness 2



Employer



Witness 1



Witness 2

- 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.
-
- 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.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

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.

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)

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

10. Project Overview

This part of the Specification provides the detail of the control and instrumentation equipment and services required for the Supply, delivery to site, installation, and commissioning of equipment to render complete operational the following sites:

- Pumps Stations 1,2 and 3

This Specification may also include descriptions of items that form the basis for payment in the Bills of Quantities. Furthermore, this document should be read together with the annexure of the control and instrumentation drawings. The drawings detail the design up to component level in some cases. Furthermore, it should be read with the standard specifications and any related standards, procedures, and regulations relevant to the Scope of work.

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.

11. 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 Pump Station 1

The Scope of work to be carried out for this section is listed below:

- Supply, installation, connection, and calibration of the following instruments:
 - Pump Station combined delivery Pressure Switch (1 of)
 - Pump Station combined delivery Pressure Transmitter (1 of)
 - Pump Station Pump-set suction Flow Switch (5 of)
 - Pump Station Pump-set suction Pressure Transmitter (5 of)
 - Pump Station Pump Vibration Sensor (5 of)
 - Pump Station Pump Bearing Temperature (5 of)
 - Pump Station Pump Casing Temperature (5 of)
 - Pump Station Pump Vibration Sensor (5 of)

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Pump Station Motor DE Bearing Temperature (5 of)
- Pump Station Motor DE Vibration Sensor (5 of)
- Pump Station Motor Winding Temperature sensor (30 of)
- Pump Station Motor Cooling Water Temperature sensor (5 of)
- Pump Station Motor Cooling Water Flow Switch (5 of)
- Test and recalibrate the following existing instruments
 - Combined Pump Station outlet Magnetic flowmeter (1 of)
 - Supply to Olifantspoort South RWS Magnetic flowmeter (1 of)
- Upgrade and commissioning of Pump Station HMI system
- Upgrade and commissioning of Pump-Station PLC system

11.2 Pump Station 2

The Scope of work to be carried out for this section is listed below:

- Supply, installation, connection, and calibration of the following instruments:
 - Pump Station combined delivery Pressure Switch
 - Pump Station combined delivery Pressure Transmitter (1 of)
 - Pump Station Pump-set suction Flow Switch (3 of)
 - Pump Station Pump-set suction Pressure Transmitter (2 of)
 - Pump Station Pump Vibration Sensor (3 of)
 - Pump Station Pump Bearing Temperature (3 of)
 - Pump Station Pump Casing Temperature (3 of)
 - Pump Station Pump Vibration Sensor (3 of)
 - Pump Station Motor DE Bearing Temperature (3 of)
 - Pump Station Motor DE Vibration Sensor (3 of)
 - Pump Station Motor Winding Temperature sensor (18 of)
 - Pump Station Motor Cooling Water Temperature sensor (3 of)
 - Pump Station Motor Cooling Water Flow Switch (3 of)
- Test and recalibrate the following existing instruments
 - Combined Pump Station outlet Magnetic flowmeter (1 of)
 - Supply to the rural area Magnetic flowmeter (1 of)
- Upgrade and commissioning of Pump Station HMI system
- Upgrade and commissioning of Pump-Station PLC system

11.3 Pump Station 3

The Scope of work to be carried out for this section is listed below:

- Supply, installation, connection, and calibration of the following instruments:

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- Pump Station combined delivery Pressure Switch (1 of)
- Pump Station combined delivery Pressure Transmitter (1 of)
- Pump Station Pump-set suction Flow Switch (3 of)
- Pump Station Pump-set suction Pressure Transmitter (3 of)
- Pump Station Pump Vibration Sensor (3 of)
- Pump Station Pump Bearing Temperature (3 of)
- Pump Station Pump Casing Temperature (3 of)
- Pump Station Pump Vibration Sensor (3 of)
- Pump Station Motor DE Bearing Temperature (3 of)
- Pump Station Motor DE Vibration Sensor (3 of)
- Pump Station Motor Winding Temperature sensor (18 of)
- Pump Station Motor Cooling Water Temperature sensor (3 of)
- Pump Station Motor Cooling Water Flow Switch (3 of)
- Test and recalibrate the following existing instruments
 - Combined Pump Station outlet Magnetic flowmeter (1 of)
 - Supply to the rural area Magnetic flowmeter (1 of)
- Upgrade and commissioning of Pump Station HMI system
- Upgrade and commissioning of Pump-Station PLC system

11.4 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:

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.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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...1.5mm².

C. Environmental Specifications

- Temperature, operating: 0 of <TA< +60 oC
- Temperature nonoperating: -40 oC ... +85 oC
- Temperature, surrounding air, max: 60 C
- Relative humidity: 5...95%.
- Vibration: 5g @ 10...5000 Hz.
- Shock, operating: 30g.



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

- 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

11.5 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



Contractor



Witness 1



Witness 2



Employer



Witness 1



Witness 2

11.6 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 option to communicate via GSM should be added to the system; this shall also be used to accommodate areas of poor RF coverage.

12. 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

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- Instrumentation hook ups drawings
- Updated Control Philosophy
- Functional Design Specification

13. 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:

1. Tests required for the commissioning of the control systems are specified in enough 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.

14. 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

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14.2 Pump Station Operation

The contractor shall train the Employer's staff to be proficient in:

- a) Fault finding.
- b) Maintenance.

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C3.10.28 PSCB - PARTICULAR SPECIFICATIONS FOR CIVIL AND BUILDING WORKS

1. Units, Symbols and Meaning of Terms

1.1 Units of Measurement and Symbols

The units of measurement are metric units as standardised by the “Système International d’Unités” (SI). Note that the comma is the decimal indicator, formally adopted by the *ISO* and the *IEC* as well, and that numerals are grouped into groups of three for readability, separated by a space, e.g. 1 233,55.

The following unit symbols (not abbreviations) are used in this document:

°C	Degrees Celsius	L	Litre
g	Gram	m	Metre
Hz	Hertz	m ²	Square metre
h	Hour	m ³	Cubic metre
d	Day	%	Percent
kN	KiloNewton	mm	Millimetre
kPa	KiloPascal	Mpa	Mega Pascal
kW	KiloWatt	t	Tonne
rpm	Revolutions per minutes		

1.2 Meaning of Terms

The following terms, highlighted in *italics* in the text of these Specifications, are explained as follows, unless otherwise defined.

1.2.1 According to Manufacturer’s Instructions

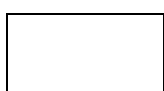
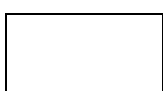
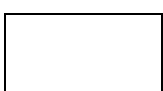
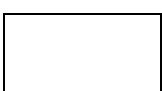
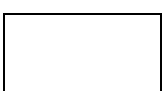
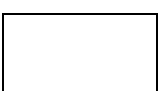
The manufacturer’s instructions at the time of tender.

1.2.2 Applicable Standard

A national or recognised standard applicable to the works, implying that the relevant standard is a contract document, a copy of which has to be kept in the office for reference purposes.

1.2.3 As Specified

As specified in the Particular Specification or in the drawing or in the scope of works.

					
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1.2.4 BS

British Standard.

1.2.5 Coastal Region

Are between the coastline and an imaginary line 30km inland, including the entire area of jurisdiction of any local authority falling within this region.

1.2.6 Competent Person

Person who is qualified by his/her education, training, experience and contextual knowledge to decide regarding the performance of a building or part thereof in relation to a functional regulation or to undertake such duties as may be assigned to him/her in terms of such regulations, as further defined in SANS 10400.

1.2.7 Comply

Meet specified standards.

1.2.8 Drawings

The drawings forming part of the contract documents, and any modification thereof or additions delivered to the Contractor during the execution of the works.

1.2.9 ISO

Universal short name of the International Organization for Standardization, a worldwide federation of national standards bodies of which South Africa, Botswana and Zimbabwe are members and Namibia, Angola, Zambia and Mozambique are correspondent members.

1.2.10 MOD AASHTO

Modified American Association of State Highway and Transportation Authority – an internationally accepted test to determine the density of compacted material like soil filling, expressed as a percentage of the maximum compaction of the filling at various moisture contents as determined in a laboratory.

1.2.11 NBR

National Building Regulations.

1.2.12 NRS

Rationalized User Specification prepared by SSA.

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1.2.13 SABS

South African Bureau of Standards.

1.2.14 SANS

South African National Standards.

1.2.15 Specification data

Data required by SANS 2001 Construction Works Standards without which the specification is incomplete.

1.2.16 SSA

Standards South Africa, a division of the SABS.

1.2.17 Suitable

Capable of fulfilling or having fulfilled the intended function or fit for its intended purpose.

2. Earthworks

2.1 Site Clearance

Applicable Standard: SANS 1200 C - Site Clearance

2.1.1 Site Clearance (General)

Clear site for the whole area of the ground to be built upon up to a least 1m beyond the perimeter of the structure of building(s) and/or extent of steps, paving, etc. This operation shall be deemed to include the digging up and removal of rubbish, debris, vegetation, hedges, shrubs and small trees (up to 200mm girth), bush, etc. as well as the digging up of top soil and examining for and removal of all dead roots and other vegetable matter likely to provide food for termites.

Prior to carrying out excavation the Contractor shall clear such areas of the sites as are necessary for the proper execution of the works of all shrubs, bushes, other vegetation, fences, rubbish, debris and other obstructive material.

Where suitable topsoil exists within the limits of the area to be excavated the Contractor shall remove the topsoil to an average depth of 100mm together with any veld grasses and other similar vegetation as directed by the Engineer. The topsoil shall be transported and deposited in temporary stockpiles. All organic material and combustible rubbish shall, with the prior written approval of the Engineer, be

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burnt on the site. Care shall be taken to observe the provisions of the National Environmental Act 1998, National Environmental Management: Air Quality Act No. 39 of 2004 and any regulation published in terms of these Acts. Care shall be taken to prevent fire from spreading to adjacent areas. Fencing wire shall be neatly wound on suitable reels and all such wire, together with all fence posts and other usable material from structures etc., shall be stacked at sites indicated by the Engineer.

2.1.2 Demolition

This Section is for the demolition of the buildings on the site, including foundations and the removal and disposal of all demolished material and disturbed ground. It includes the provision of all precautionary safety measures, screens, scaffoldings, hoarding, covered walkways and the like, for carrying out the demolition work.

Areas adjacent to demolition works shall be protected from damage resulting from the demolition including the preservation of existing protected tree species.

Structures that are to be demolished shall be surveyed by the contractor and the result given to the Engineer, before demolition starts.

Particulars of the proposed methods of carrying out demolition works, handling and sorting of recyclable material and disposal of construction and demolition waste shall be submitted to the Engineer for information at least 14 (fourteen) days before the demolition starts.

The contractor must visit the site and examine the building(s) on the site and those adjoining and shall be fully aware of any and all circumstances that may affect the demolition of the buildings. This includes the materials comprising the buildings to be demolished. It also includes satisfying themselves as to site conditions, levels, access, services, adjoining buildings and all other matters affecting the execution of the Contract.

The demolition work shall be carried out by a competent firm of contractors employing skilled workmen experienced in this type of work. The Contractor shall keep a competent Foreman on site at all working times. The Foreman shall be empowered to receive and act on instructions given by the Engineer.

The Contractor shall notify the Engineer of the name of his/her Safety Supervisor prior to commencement with the demolition work, who shall be knowledgeable in the updated Department of Labour demolition requirements.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The proposed methods shall enhance site safety, maximise recovery of recyclable materials and minimise generation of construction and demolition waste. The Contractor shall erect all necessary temporary supports to prevent any unexpected collapse of any part of the building during demolition. The Contractor to assume responsibility for all temporary works. The Contractor shall be solely responsible for the entire safety of the work and no indication of approval or disapproval of any demolition methods and sequence, shoring, screen, protection works, etc. by the Engineer shall be interpreted as in any way reducing the Contractor's responsibility for the same.

The latest recommendations of the Department of Labour Demolition Work (Regulation 21 Asbestos Regulations), Occupational Health and Safety Act, 1993 (Act 85 of 1993), and other relevant regulations shall be followed.

The use of explosives is prohibited.

The Contractor should not remove support to, undermine, or in any way lessen the capacity of foundations to structures on adjoining sites. If foundations cannot be removed without affecting the stability of the neighbouring buildings, advice must be sought from the Engineer before proceeding. The Contractor shall provide all necessary measures to secure the site against unauthorised entry. On completion of the work, the Contractor shall securely fence the site per the fencing specifications. All materials, debris and other items arising from demolition shall become the property of the Contractor unless specifically stated otherwise, and due allowance for the credit value (if any) of such materials, items, etc. shall be made in the tender. Carefully dismantle any material that is to remain the property of the Owner, store and protect until completion of the works and hand over to the Owner. The site is to be left clear of all demolition and related and all disturbed ground.

Any ground that is disturbed shall not be re-compacted but shall be removed from the site. The only exception to this is adjacent to the street boundary where the ground shall be banked up to protect the back of the footpath from damage. The site is to be left essentially level and in all cases lower than the nearest adjoining footpath.

The Contractor shall remove off-site all salvaged materials, debris arising from demolitions and discard all rubbish left on site by the previous occupants to a legal waste disposal site to be provided by the Contractor. The Contractor shall remove debris and rubbish in such a manner as to cause a little inconvenience as possible to the adjoining owners and the public.

The Contractor shall not burn debris, rubbish or salvaged material on site. The Contractor shall not

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

allow demolished materials to accumulate on site.

The Contractor shall ensure that the streets, roads and paths are not obstructed, and the traffic is not impeded due to loading and off-loading materials for the work.

The Contractor shall conform to Police and Local Authority regulations for carting, loading and off-loading all materials, plant, earth and debris, etc. to or from the work.

2.2 Earthworks (General)

Applicable standard: SANS 1200 D Earthworks (general).

2.2.1 Approval of Operations

Prior to the commencement of each section or type of excavation, the Contractor shall submit to the Engineer, for approval, a detailed programme of operations, methods and plant to be used for executing that section or type of excavation, including details of dewatering, pumping, shoring, drilling patterns, etc. The Engineer's approval will not be unreasonably withheld provided the method and equipment proposed can be expected to produce an acceptable end results and such approval shall not relieve the Contractor of his/her responsibilities for safety, programme or any other requirements of the contract.

The Contractor may use any method he/she chooses to excavate any class of material, but his/her chosen method of excavation of the material to be excavated. The Engineer will decide and approve the classification of the material to be excavated.

2.2.2 Classification of Material

Soft Excavation: - Shall be excavation in material that can be efficiently removed by a back-acting excavator of flywheel power approximately 0.10 kW per millimetre of tined-bucket width without the assistance of pneumatic tools such as paving breakers, or that can be efficiently loaded without prior ripping or stockpiling by a rubber tired front-end loader of approximately 15t mass and a flywheel power of approximately 100kW.

Intermediate Excavation: - Shall be excavated in material that requires a back-acting excavator of flywheel power exceeding 0,10kW per millimetre of tined-bucket width and the assistance of pneumatic tools prior to removal by equipment equivalent to that specified in (a) above.

Hard Rock Excavation: - Shall be excavation in material that cannot be efficiently removed without

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

blasting or without wedging and splitting prior to removal.

Class A Boulder Excavation: - Shall be excavation in material containing more than 40% by volume of boulders of size between 0.03m³ and 20 m³ in a matrix of softer material or smaller boulders.

Note:

- i. Excavation of solid boulders or lumps of size exceeding 20 m³ will be classed as hard rock excavation.
- ii. Excavation of fissured or fractured rock will not be classed as boulder excavation but as hard rock or intermediate excavation according to the nature of the material.

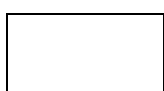
Class B Boulder Excavation: - Shall be excavation of boulders only in a material containing 40% or less by volume of boulders of size between 0.03m³ and 20 m³ in a matrix of softer material or smaller boulders.

Note:

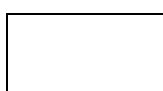
Those boulders requiring individual drilling and blasting in order to be loaded by a back-acting excavator as specified in (a) above, or by a track type front-end loader, will each be separated measured as Class B boulder excavation. The excavation of the rest of the material will be classed as soft or intermediate excavation according to the nature of the material.

2.2.3 Method of Classifying

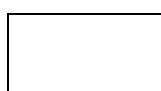
- a) The Contractor may use any method he/she chooses to excavate any class of material but his/her chosen method of excavation shall not determine the classification of the excavation. The Engineer will decide on the classification of the materials. The classification will be based on inspection of the material to be excavated and the criteria given in Section 1.2.2(a) to (e) above, as applicable. The decision of the Engineer shall be, subject to the relevant provisions of the contract, final and binding.
- b) Should the Contractor consider that the excavation is other than "soft excavation" he/she must notify the Engineer immediately in order that an inspection be made, and a decision arrived at by the Engineer as to the category of such excavation. Should the Contractor fail to give such notification, the excavation shall be deemed to be "soft excavation" and shall be measured and valued accordingly.
- c) Blasting will only be permitted with the written authority of the Engineer, if and when permission is granted, it is to be executed only by persons holding the necessary Government Blasting Certificate and subject to all regulations imposed by the Engineer and/or Local Authority. In addition, the Contractor is to indemnify the Provincial Administration against all claims in respect of damage to persons and property resulting from such blasting operations.



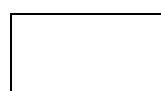
Contractor



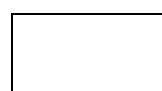
Witness 1



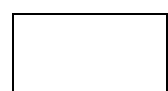
Witness 2



Employer



Witness 1



Witness 2

- d) Before commencing any excavations, the Contractor must satisfy himself/herself as to the accuracy of any levels indicated on the drawings, as no claim will be entertained at a later date for any alleged inaccuracy in such levels.
- e) Excavation shall be carried down to such depths as are necessary to obtain firm foundations, but before proceeding to greater depths than are shown on the drawings, the Engineer's approval must be obtained.
- f) The Contractor will be responsible if he/she excavates wider or deeper than shown or required. If the excavations are deeper than shown or required such extra excavations are to be filled in with mass concrete at the Contractor's expense. If the excavations are wider than shown or required, any form-work or mass concrete filling required to the side of the concrete foundations is to be executed at the Contractor's expense and to the approval of the Engineer.
- g) Depths of excavations as approved shall be checked and recorded by the Engineer or his/her representative and the Contractor's Foreman before any concrete is poured or the excavations covered or filled in.
- h) Notwithstanding such approval, any excavations which become waterlogged or otherwise spoil after approval, shall be cleaned out and reformed, at the Contractor's expense and to the satisfaction of the Engineer, before any concrete, etc. is poured.

2.2.4 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.

2.2.5 Explosives

- a) The use of explosives is prohibited.

2.2.6 Notice to the Engineer

- a) The Engineer shall, at least, be given a forty-eight (48) hours' notice prior to commencement of each stage of the work.
- b) Proposed methods of completing each phase of the work shall be discussed and agreed prior to starting.
- c) The Contractor shall advise the Engineer, with adequate notice, when foundation inspections are to be made. Twelve (12) hours minimum notice shall be deemed as being adequate.
- d) The Engineer shall inspect the base of the excavation. Inspection shall not relieve the Contractor of responsibility to check and verify that the work conforms to this Specification.

2.2.7 Excavation for Services

The Contractor shall excavate for all services, including plumbing, drainage, electrical, gas, and

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

telecommunications, as indicated.

The Contractor should cross reference with the Architect's Drawings prior to commencing with excavations.

2.2.8 Dewatering

No water shall be allowed to accumulate in any portion of the excavations. If water enters excavations which are meant to receive concrete, the water shall be pumped out and any soft materials unsuitable for receiving concrete shall be removed and replaced with clean material. Water must be drained in such a way that it cannot seep or flow back into the excavation.

2.2.9 Other Trades

The Contractor must co-operate with the Drainlayer and Plumber, who will be laying pipes, sumps and wastes.

2.2.10 Hazardous and Contaminated Materials

Should the Contractor, during excavation work, encounter materials which appear to be hazardous or contaminated in any way such that they would not be accepted at a conventional landfill site, the Contractor shall immediately cease work which could spread the hazardous material or worsen the contamination and advise the Engineer, seeking instructions on how the work should proceed. Removal of such material will constitute a variation.

2.2.11 Disposal of Excavated Material

- a) Part Return:
 - i. Material from the excavations, after testing by an approved Independent Laboratory, where suitable and approved by the Engineer, is to be returned, filled in and rammed against foundation walls, under floors, steps, etc. as necessary.
 - ii. No clay shall be used as filling or backfilling material.
- b) Deposit on Sites:
 - i. The excess material shall be deposited on site, spread and roughly levelled, where permitted.
- c) Cart Away:
 - i. Surplus material is to be carted away to a suitable waste disposal site or similar, to be identified by the Contractor, outside the boundary of the site.

2.2.12 Maintenance of Excavations

- a) Planking, strutting, shoring and temporary sheet piling be measured as such only when

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

prescribed.

2.2.13 Risk of Collapse

- a) The Contractor shall maintain all excavated faces exceeding 1,5m deep in accordance with Department of Labour Safety Regulations and all excavated faces not exceeding 1,5m deep affecting the safety of the work and/or the workmen.
- b) The Contractor shall carry out risk assessment of collapse of excavated faces whether or not he/she takes any precautions, the nature of which shall be entirely at his/her own discretion.

2.2.14 Completion of Excavations

- a) The Contractor shall give notice, in writing, to the Engineer when the excavations are ready to receive the foundations.
- b) 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.

2.2.15 Filling

- a) Filling shall be of approved clean earth in layers not exceeding 150mm in depth, well-watered, rammed and thoroughly consolidated to at least a density of 90% Modified AASHTO (American Associations of State Highway and Transportation officials), which will be verified by the Engineer having it been tested.
- b) All filling material shall be approved beforehand by the Engineer prior to placement. A sixty (60) kg sample of the proposed fill is required by an approved Laboratory for this purpose and fourteen (14) days must be allowed for initial sample testing.
- c) Before filling is placed, the virgin soil shall be scarified and compacted to at least 90% Modified AASHTO. Each layer of filling must be tested by an approved Laboratory and approved by the Engineer before the next layer is placed and compacted.
- d) Filling shall be dealt with as follows:
 - i. To defined levels:
 - 1. The required ground levels outside the buildings shall be made up with earth filling, as above, and graded to falls as shown on the drawings, or as directed.
 - 2. Sloping banks made up of earthen material shall be of such angle as will maintain the stability of the ground above and shall be neatly trimmed.
 - ii. To foundations etc.:
 - 1. Filling to foundations etc. shall be of earth filling as above.
 - 2. The filling of areas under solid floors shall be carried out as soon as the foundations and foundation walls have been completed.

Contractor

Witness 1

Witness 2

Employer

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Witness 2

- iii. Thickness of compacted material:
 - 1. Given thicknesses are those for compacted material.
 - 2. The Engineer shall keep notes on all filling supplied by the Contractor.
- iv. Description (prices):
 - 1. Descriptions (prices) of 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.

2.2.16 Surplus Earth

- a) All surplus earth, topsoil and/or other materials from the excavations shall be deposited and levelled on the site, or carted away, as directed by the Engineer.

2.2.17 Gravel Dressing

Gravel dressing to the ground outside the building 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.

2.2.18 Garden Soil Filling

- a) 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. For food gardens the soil should be ripped, any rocks and boulders removed, disked and levelled.

2.2.19 Verification Testing

- a) The Contractor shall employ an independent laboratory to undertake site tests to verify compliance with compaction tests for all backfilling, hardfilling and capillary break material. Testing shall be at the rate of 1 per 30m³ placed or at any other frequency instructed by the Engineer. All costs of testing shall be borne by the Contractor.
- b) Testing should be undertaken using a nuclear densometer.

2.2.20 Protection Against Termites

- a) 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 of solution per m². 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.
- b) Where the ground to be treated is of earth filling, the upper layer of the fill shall be levelled by

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

raking, but where of natural ground, it shall be dug up, well loosened to a depth of not less than 50mm 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.

- c) Before applying the solution to the ground under the floor, 75mm deep V-shaped channel shall be raked out alongside all walls enclosing the floors and against sleeper walls and piers etc. under floors and channels flooded with poison solution. After the solution has soaked in, the channels shall be back filled and rammed.
- d) The bottom of all foundation trenches and holes shall be similarly poisoned, but without digging up and loosening the soil.
- e) The poisoned layer of soil under suspended wood floors shall be protected with a 75mm thick layer of approved clean gravel or broken stone, levelled to an even surface on top, leaving a clearance.
- f) Where the 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.
- g) 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:

- i. The soil poison shall be delivered to site in sealed containers, clearly labelled or stamped, with the name of the product.
- ii. Contractors are advised that special precautions must be taken to protect the workmen working with the soil poison.
- iii. 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.
- iv. The poisoning of the ground must be carried out under the supervision of the Engineer.
- v. All Government laws and regulations, as well as local authorities' regarding termite poisoning, shall be strictly adhered to.

2.3 Temporary Structures

- a) The Contractor shall be responsible for the design of all temporary structures to be used by the Contractor and his/her staff during construction. Calculations for temporary works shall be submitted to the Engineer for review. Method statements for the erection of the temporary works shall also be included.

Contractor

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Witness 2

Employer

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- b) Structures shall be designed for all imposed loads in accordance with SANS 10160 or as specified by the Engineer including any uniformly distributed or point loads during maintenance.
- c) Temporary structures to be used temporarily by the end-users while permanent structures are being constructed shall be designed by the Engineer, or such designs shall be approved by the Engineer if they are carried out by the Contractor.

2.4 Alterations

2.4.1 Site Visit

- a) Tenderers are advised to visit the site prior to tendering and satisfy themselves as to the nature and extent of the work to be done, also to examine the condition of all existing buildings as no claim will be entertained on the grounds of ignorance of the conditions under which the work was to be executed.

2.4.2 Materials from the Alterations

- a) Unless otherwise stated, the waste material from the alterations will become the property of the Contractor and all these materials, together with all rubbish and debris must be carried away and the site left clean and unencumbered.
- b) Credit for the value of materials from the alterations is to be allowed for on the Summary/Final Summary page of the schedule of quantities.
- c) Items described as to be reused or handed over to the Engineer are to be dismantled where necessary and stacked on site where directed, and the Contractor will be responsible for their removal and storage until required, and shall make good all items missing, damaged or broken at his/her own expense.
- d) Unless otherwise described no materials from the alterations shall be re-used in any new work without the written approval of the Engineer.
- e) Prior to the removal of any timber from the site, it has to be inspected by a Government Entomologist. If any of these timbers are infested by wood destroying agencies, these timbers are to be disposed of in the manner prescribed by the Government Entomologist.
- f) In taking down and removing existing work, particular care must be taken to avoid any structural or other damage to the remaining portions of the building.

2.4.3 Asbestos regulations 2001

All asbestos work shall be carried out under the supervision of an "Approved Inspection Authority" as per the Asbestos regulations 2001 of Occupational Health and Safety Act, 1993 (Act No. 85 Of 1993).

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

2.4.4 Notice of Disconnections

- a) The Contractor is to give ample notice to the Engineer and Local Authorities regarding any disconnections necessary prior to the removal or interruption of electrical or telephone cables, water supply and sanitary services, etc.

2.4.5 Dust

- a) The Contractor is to allow in his/her rates for taking all precautions necessary to prevent any nuisance from dust whilst carrying out the work.

2.4.6 Shoring

- a) Rates for shoring are to include the use and waste of all props, needles, wedges, braces, nails and screws, etc. required and for all cutting, notching, framing and fitting, maintaining in position for the required periods and removing at completion. All shoring is to be executed in a manner approved by the Engineer.

2.4.7 Matching of Existing Work

- a) The terms “make good” to existing work as described in the items shall mean making good with materials to match, all joined to existing.

3. Concrete Works

3.1 Structural works

Applicable standard: SANS 2001- Construction works Part CC1: Concrete Works (structural) – covers: structural concrete in buildings and structures where the design and supervision of reinforced pre-stressed and pre-cast concrete.

Summary requirements for structural elements (Foundations, Columns, Staircases, Beams, Suspended Slabs, Concrete Roof Slabs, etc., given on the General Standard Drawings.

3.1.1 Materials

- a) Concrete shall be to the grade noted on the Drawings. The Contractor is responsible for the design of strength of concrete.

3.1.2 Cementitious Binders

- a) To comply to clause 4.2.1 of SANS 2001-CC1.
- b) Provide waterproof storage.
- c) Use binder that was delivered first on site.

Contractor

Witness 1

Witness 2

Employer

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- d) Do not keep binders longer than eight (8) weeks after being purchased from the supplier.
- e) If required by the Engineer, the Contractor shall provide certificates of tests showing that the cement on the site conforms to these Specifications and requirements. All cement used on the work shall at all times be subject to the approval of the Engineer and any cement rejected shall be immediately removed from the site.
- f) The Contractor shall render to the Engineer a dialy return showing the quantities of cement and milled slag or pulverised fly ash received on site and used, and the balance in stock. The Engineer is to have access to the stores and records at all times for the purpose of checking such returns.
- g) No empty cement bags shall be removed or used for other purposes until authorized by the Engineer. If requested the Contractor shall immediately remove all such bags from the site.

3.1.3 Water

- a) Water for mixing concrete should be clean and shall meet the requirements of clause 4.2.2 of SANS 2001-CC1.
- b) The quality of water used in each batch of concrete shall be carefully adjusted to maintain the water cement ratio required for the particular mix.
- c) The quality of water added to each batch shall be fixed by an automatic attachment on the concrete mixing machine and shall not be added by means of hands buckets, hoses or any other method by which the quality is not accurately determinable.
- d) The water shall be carefully measured so as to ensure the same quality being used in each batch of concrete.

3.1.4 Aggregates

3.1.4.1 Fine Aggregate

- a) To conform to the requirements of clause 4.2.3 of SANS 2001-CC1.
- b) Fine aggregate shall be entirely free from organic material or any other foreign matter.
- c) Samples of the proposed fine aggregate shall be submitted to the Engineer for his/her approval before use. The Contractor shall submit a sieve grading analysis to the Engineer for approval and, if unacceptable, the Contractor shall offer another sample and grading for approval or may blend aggregate from different sources and submit the blend for the Engineer's approval.
- d) Fine aggregate shall be stored on a concrete surface and washed sand be allowed to drain for at least twenty-four (24) hours before use. The Engineer may require the Contractor to test the sand daily (or more frequently if necessary) for moisture content, impurities and grading before use.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

3.1.4.2 Coarse Aggregate

- a) To conform to the requirements of clause 4.2.3 of SANS 2001-CC1.
- b) Single sized aggregates shall be stored on a concrete surface in separate stock piles, according to size.
- c) The proportions of the various single sized aggregates required for the various portions of the work shall be submitted by the Contractor for the Engineer's approval.
- d) Samples of the proposed coarse aggregate shall be submitted to the Engineer for his/her approval before use.

3.1.5 Admixtures, Air-Entrainment Agent and Curing Agents

- a) To comply to clause 4.2.4 of SANS 2001-CC1.
- b) Admixtures shall only be approved by the Engineer when it is proved that such admixtures, agents will not have deleterious effect on the essential qualities of concrete is supported by substantial evidence.

3.1.6 Steel Reinforcement

- a) To comply to clause 4.2.5 of SANS 2001-CC1.
- b) Reinforcing bars shall comply with the requirements of SANS 920 – latest edition.
- c) Welded mesh fabric shall comply with the requirements SANS 1024 – latest edition.
- d) Welded joints in tensile reinforcing bars will not be permitted.
- e) The size, length and bending of the reinforcing bars shall be strictly in accordance with the bending schedules and drawings.
- f) All bending shall be done cold and in accordance with SANS 82 – latest edition.
- g) Bars already bent shall not be straightened for re-use.
- h) All reinforcement shall be clean and free from scale, loose rust, grease, oil, mud and other coatings which may reduce the bond between the steel and surrounding concrete, affect durability of the concrete or initiate corrosion of the reinforcement.
- i) All reinforcement stored on the site shall be stacked under cover and off the ground.

3.1.7 Grade of Concrete

- a) The grade shall be as specified by the Engineer.
- b) Precast concrete grade to be at as specified on the drawings.

3.1.8 Grout

- a) To comply with clause 4.2.7 of SANS 2001 – CC1.
- b) To comply with SANS 50197 – 1.

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- c) Minimum strength to be 32.5 MPa.

3.1.9 Tendons

- a) To comply with clause 4.2.8 of SANS 2001 – CC1.

3.1.10 Sheaths

- a) To comply with clause 4.2.10 of SANS 2001 - CC1.

3.1.11 Joints Fillers, Sealants, Waterstops, Bearings and Accessories

- a) To comply with clause 4.2.11 of SANS 2001 – CC1.

3.1.12 Deteriorated Material

- a) Deteriorated, contaminated and damaged materials shall not be used in concrete works and should immediately be removed from site.

3.1.13 Formwork

- a) To conform to the requirements of clause 4.3 of SANS 2001 – CC1.

3.1.13.1 General

- a) The Contractor shall supply, fix and subsequently remove all the necessary formwork, supports, falsework, shoring, templates, staging, etc. required for the placing of concrete and the cost of doing so shall be included in the tendered rate for formwork.
- b) All the formwork shall be well designed and accurately made, assembled and erected by the Contractor. The use and design of forms with a height exceeding 1,5m shall be subject to the Engineer's approval.
- c) Forms shall be made of sound material (damaged or distorted forms shall not be used) securely supported, braced and tied to prevent deformation or displacement due to any load, or combination of loads, which might be imposed thereon, including the mass and pressure of wet, vibrated concrete, vibration due to the movement of men, materials and equipment, wind loads, etc.
- d) All joints in formwork shall be sufficiently tight to prevent the escape of mortar, and where necessary shall be sealed with adhesive tape or other approved material.
- e) Surfaces of formwork that are to be in contact with fresh (wet) concrete shall be treated by coating with an approved non-staining material to ensure easy release and non-adhesion to the formwork during stripping.
- f) Steel forms shall be used for column shafts and heads. To prevent cracking and spalling of previously cast sections of column shafts, column forms shall be erected, aligned and securely

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stayed before the bolts clamping the form to the previous cast concrete are tightened.

- g) All formwork shall be thoroughly cleaned before re-use.
- h) Formwork shall be designed to allow stripping without jarring or damaging the concrete.
- i) Any runways required for the placing of concrete shall be so constructed as to be entirely independent of the concrete formwork.

3.1.13.2 Classification of Finishes

- a) Formwork will be classified in accordance with the surface condition required on the finished concrete as classified in Table 1 of SANS 2001-CC and the treatments thereof adhered to.

3.1.13.3 Stripping of Formwork

- a) To comply with clause 4.3.8 of SANS 2001-CC1.
- b) Formwork shall be removed carefully so as not to damage the concrete and shall not be stripped until the following periods have elapsed after concreting has taken place for the various portions of the work as listed in Table 2 SANS 2001-CC1.
- c) The above periods may be reduced at the discretion of the Engineer provided it can be shown that the compressive strength of the concrete has reached at least fifty per cent (50%) of that specified for the twenty-eight (28) days works cubes compressive strength.
- d) When stripping slab and beam soffits, other than cantilevers, one prop in the centre of the span shall be left for a further period of seven (7) days.
- e) In very cold weather the Engineer may order formwork to be retained in position for periods at least fifty per cent (50%) longer than those given above.

3.1.13.4 Chamfers

- a) All arises shall be chamfered off to approved dimensions but not exceeding 35mm wide on the splay.

3.1.14 Construction Tolerance

- a) The Contractor shall construct each of the various elements of the work within the limits of the applicable permissible deviation set out in Table 11 of SANS 2001-CC1.

3.1.15 Reinforcement

- a) To conform to the requirements of clause 4.4 of SANS 2001-CC1.
- b) The reinforcing bars shall be placed accurately in the positions to give the minimum cover shown on the detailed drawings. The bars shall be wired together with 1,6mm diameter wire at every second point of intersection and shall be fixed so as to prevent any displacement

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during concrete. Wire tie ends shall point away from the nearest formwork face.

- c) All placing of reinforcement shall be done well in advance of the concrete and no concrete shall be placed until the reinforcement in position has been inspected and passed by the Engineer.
- d) Bending, aside of reinforcement to facilitate placing of concrete, shall be kept to a minimum and will be permitted only at certain points approved by the Engineer. Such reinforcement shall be accurately re-bent to its correct shape and position before the concrete is placed round it.
- e) Unless shown on the drawings, reinforcing bars shall not be cut to accommodate holes for pipes or bolts etc. where such holes foul reinforcement the bars shall be moved to positions indicated by the Engineer.
- f) Where reinforcing bars project beyond sections of concrete which are about to be cast, such projecting bars shall be firmly supported and held in position to obviate damage to the newly cast concrete.
- g) Concrete spacer blocks shall be of cement-sand mortar mixed in proportions by mass to be approved by the Engineer, compacted by vibration to a density equal to that of the surrounding concrete and cured as specified.
- h) The use of plastic, timber spacer blocks or any other material other than concrete will not be permitted.
- i) Laps to be as detailed on the drawings.
- j) Concrete cover to be as detailed on the drawings.
- k) Embedded items (Joint material, water-stops, pipes and conduits, etc.) to be accurately positioned and supported to ensure no displacements.
- l) Voids to be temporarily plugged with removable material to prevent entry of concrete into the voids.

3.1.16 Embedded Items

- a) To comply to the requirements of clause 4.6 of SANS 2001-CC1.
- b) All sleeves, inserts, anchors and embedded items required for adjoining work or for its support shall be placed prior to concreting.
- c) All Contractors, whose work is related to the concrete or must be supported by it, shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is poured.
- d) Any exposed threads shall be taped to prevent concrete or mortar adhering to the thread prior to concrete being poured.
- e) Pipe penetrations within concrete structures should be as shown on the construction

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drawings.

- f) Drainage pipes to be clean.

3.1.17 Quality of Concrete

- a) The concrete mix for each portion of the work shall satisfy the strength and durability requirements.
- b) The concrete mix for each portion of the work shall be specially designed by the Contractor to comply with the cube compressive strength at twenty-eight (28) days specified by the Engineer and shall be subject to the prior approval in writing of the Engineer.
- c) The slump shall not exceed the values listed in Table 4 of SANS 2001-CC1.
- d) Prior to the beginning of the work the Contractor shall submit a statement of the proportions for each grade of concrete, together with a report in detail from an approved testing laboratory showing for at least three (3) different water contents the seven (7) day and twenty-eight (28) day concrete cube strengths obtained when using the materials proposed for the work.
- e) Chloride and sulphate content not to exceed the applicable values in Table 5 of SANS 2001-CC1.
- f) Ready mix concrete, if specified in the scope of works, should be in accordance with SANS 878.
- g) Concrete to be transported as per Clause 4.7.9 of SANS 2001.
- h) Concrete shall be conveyed from the mixer to the point of deposition in grout-tight barrows, bottom-dump buckets, skips, chutes or other approved methods, in such a way as to avoid contamination, segregation of change in water content of any part of the batch. No pumping of concrete for structural sections will be permitted. The Engineer's decision in all matters concerning transportation of concrete shall be final.
- i) Where segregation occurs during transportation, the concrete shall be re-mixed by hand before being deposited in position.

3.1.18 Placing of Concrete

- a) To conform to the requirements of clause 4.7.10 of SANS 2001-CC1.

3.1.18.1 Preparation

- a) No concrete shall be mixed until the foundations, ground water handling arrangements, reinforcement, joint treatment, clean up, formwork and concrete mixing, handling and placing equipment have been approved by the Engineer.

3.1.18.2 Placing

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- a) Concrete from containers shall be deposited as nearly as practicable directly into its final position and shall not be allowed to flow in any manner which might cause segregation.
- b) All concrete shall be placed in its final position within twenty (20) minutes of leaving the mixer and work shall proceed continuously until each cast is completed or formed to approved construction joints.
- c) All excavations and other contact surfaces of an absorbent nature shall be left damp, but no free water shall be permitted to remain on these surfaces. Wherever concrete is to be placed in wet ground the Contractor shall excavate shallow drains below the foundation surfaces connected to suitably placed sumps. The drains shall be filled with crushed rock and covered with site concrete which will form the foundation level for structural concrete. All the procedures for controlling water in the excavations shall be approved by the Engineer and the cost of any such measures shall be included in the rate for dewatering excavations.
- d) Except in columns and piles, no concrete shall be permitted to drop freely from a height in excess of 2m. Concrete in columns shall not drop freely from a height in excess of 4m.
- e) Chutes shall be inclined at least one-and-a-quarter ($1\frac{1}{4}$) vertical to one (1) horizontal, shall not exceed 3m in length, shall be maintained clean and in good condition and shall be fitted with an approved end control which will ensure a vertical drop of concrete from the end of the chute.
- f) The method of placing and all plant used shall be subject to written approval by the Engineer.

3.1.18.3 Compaction

- a) To conform to the requirements of clause 4.7.11 of SANS 2001-CC1.
- b) The concrete shall be placed so as to prevent segregation and shall be thoroughly compacted by hand tools and where the concrete is more than 130mm thick, by approved internal vibrators of ample power to maintain a speed of at least 7000 rpm when immersed. Supplementary hand spreading, tamping and spading shall be carried out as directed by the Engineer and in no case shall vibrators be used to cause flow of concrete after placing.
- c) Vibration shall be systematically applied by competent workmen at intervals sufficiently close to ensure that the whole volume of concrete is fully compacted and shall continue for an ample but not excessive time at each insertion. The entire depth of each layer of concrete shall be vibrated, and the vibrator shall at each insertion penetrate approximately 50mm into the layer below, or the strip adjacent, in order to provide a complete bond between successive layers or strips. Standby vibrators with an independent source of power shall be maintained on site ready for immediate use.
- d) The method of compaction and the equipment used shall be approved by the Engineer.
- e) The concrete shall surround the reinforcing bars completely. The reinforcing bars shall not be

Contractor

Witness 1

Witness 2

Employer

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displaced when depositing or working the concrete.

- f) All concrete shall be compacted before any initial set has taken place and in no case more than 20 minutes after having been discharged from the mixer. Overnight leavings shall not be used in any way but shall be discarded and immediately removed from the site.
- g) The concrete shall not be disturbed or shaken while it is setting.
- h) Workmen engaged in placing of concrete shall be provided with waterproof knee boots and oilskins shall be provided for all men employed on concreting and all other necessary protection to ensure satisfactory completion of any cast in wet weather.
- i) Concrete which has, in the opinion of the Engineer, is bleeding or has excessive water content, due to over-vibration or any other cause, shall be removed and replaced with concrete of an approved consistency.

3.1.19 Adverse Weather

- a) Weather conditions under which concrete should be poured must conform to the requirements of clause 4.7.14 of SANS 2001-CC1.
- b) During cold weather no material having a temperature below 5°C shall be used for making concrete.
- c) No concrete shall be placed when the ground or air temperature is below 2°C or if the ground or air temperature is likely to fall below 2°C within six (6) hours of pouring the concrete.
- d) During hot weather, the temperature of the concrete, as placed, shall not exceed 30°C.
- e) The Contractor shall ensure that the placing temperature of the fresh concrete does not exceed the ambient temperature by more than 5°C. Where necessary, this shall be accomplished by shading aggregate stockpiles, shading or insulating water pipes and water storage tanks.

3.1.20 Joints

- a) All joints shall conform to the requirements of clause 4.7.12 of SANS 2001-CC1, in accordance with the scope of work.

3.1.21 Construction Joints

- a) Construction joints will be permitted only where shown on the drawings or approved by the Engineer and shall be formed true to line on all formed or exposed surfaces. Horizontal joints shall be formed by casting against a timber or metal former. Recesses shall be formed as detailed on the drawings. Where detailed on the drawings, galvanized metal strips or water-bars shall be cast into the joints.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- b) For forming joints refer Table 7 of SANS 2001-CC1.
- c) Immediately before the adjoining concrete is placed, the chipped surface shall thoroughly cleaned by brushing and washing and the thoroughly wetted.
- d) Proprietary joints shall be strictly in accordance with the manufacturer's instructions.
- e) The methods of forming construction joints are to conform to Table 7 of SANS 2001-CC1.

3.1.22 Curing and Protection

- a) To conform to the requirements of clause 4.7.13 of SANS 2001-CC1.
- b) All concrete other than site concrete and porous and concrete, shall be maintained continuously saturated for at least seven (7) days after placement or after stripping formwork in the case of walls, by methods which shall receive the prior written approval of the Engineer if different from the following:
 - i. Ponded water with a minimum depth of 30mm;
 - ii. Saturated sand with a minimum thickness of 75mm;
 - iii. Continuously saturated heavy jute sacking, or other approved absorbent material maintained in contact with the concrete surfaces by fastenings spaced at not more than 1m centres;
 - iv. Continuous sprinkling of the entire area of concrete (periodical hosing down will not be accepted); or
 - v. Covering the previously saturated surfaces with approved plastic sheets maintained in contact with the concrete surfaces and with all edges and joints sealed by methods approved by the Engineer.
- c) Newly cast concrete sections shall not be used for supporting loaded wheelbarrows, mono-rails, material or scaffolding, etc., until permission is obtained from the Engineer.
- d) The use of curing compounds will not be permitted, particularly on horizontal slabs, without the prior written approval of the Engineer. This should be used in strict accordance with the manufacturer's instructions.
- e) Curing shall continue for at least the minimum period of time given in Table 8 of SANS 2001-cc1.

3.1.23 Concrete Finishes and Defects

- a) Finishes to conform to the requirements of clause 4.7.15 of SANS 2001-CC1.
- b) Defects to be rectified and repaired.
- c) Rubbing down of concrete surfaces to be done to the requirements of clause 4.7.20 of SANS 2001-CC1.

3.1.24 Testing of Concrete

- a) To conform to the requirements of clause 5 of SANS 2001-CC1.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

- b) During the progress of construction, tests shall be made under the direction of the Engineer to determine whether the concrete being produced complies with the standards of quality and strength specified.
- c) The Contractor shall be responsible for the mixing, curing and testing of all cubes and shall submit test results from an approved laboratory.

3.1.25 Minor Works

Applicable standard: SANS 2001-Construction Works Part CC2: Concrete Works (minor works).

3.1.25.1 Foundations

Applicable standards: SANS 2001- Construction Works Part CM2: Strip Footings, Pad footings, Raft foundations and Slab-on-the ground Foundations for Masonry Walling.

- a) Form and cast all foundations as detailed. Foundations are to be cast against formwork on each side unless otherwise approved by the Engineer. Where approval is given to cast against ground an extra 25mm thickness of concrete will be required on each unformed face to provide additional cover.
- b) Allow to underpin or otherwise support adjacent foundations as necessary to ensure complete stability and no damage to adjacent buildings at all times.
- c) Cast in sleeves for all pipes and cables through foundations.
- d) Foundations trenches shall be cleaned prior to placing concrete. All foundations shall be free and clear of loose material and debris prior to pouring concrete. All reinforcing shall be cleaned prior to pouring of concrete.
- e) The Engineer shall be advised in sufficient time to inspect all foundation excavations before the placing of any tidy concrete or hardfill.

3.1.25.2 Concrete Floors and Surface Beds

- a) Floor: direct-finished one course slab as specified below, or as designed and constructed to SANS 10109 under direction of a *competent person* (Civil Engineer) when specified.

3.1.25.3 Blinding Layer

- a) A nominal minimum blinding layer should be 50mm thick and 15MPa strength, to level the area before pouring concrete foundation.

3.1.25.4 Damp-proof under-surface membrane

- a) Material: polymer film SANS 952 type C(green) 0,25mm thick.
- b) Cutting: straight and square or to shape; use sharp instruments.
- c) Joints: minimum lapped and sealed with pressure sensitive tape.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

3.1.25.5 Fabric reinforcement

- a) Welded steel fabric: SANS 1024.
- b) In large mats, overlap 300mm, place near top surface.
- c) Do not cross over construction or day joints.

3.1.25.6 Preparation

- a) Prepare thresholds before casting floor by casting concrete of same thickness, material and finish as specified for floor, in all door openings; thresholds to have keyways.
- b) Prepare for contraction, construction and isolation joints; in case of columns, place edge forms diagonally to column.
- c) Lay damp-proof membrane with sheet overlaps of 200mm over entire floor area.

3.1.25.7 Placing

- a) Place, compact, level, strike off, and wood float concrete floors to thickness, level, and/or gradient as specified.

3.1.25.8 Finishing

- a) Direct-finish by means of delayed troweling technique:
 - i. Leave surface undisturbed until bleeding has ceased, and surface has stiffened so that foot pressure barely indents the surface (2-4 hours)
 - ii. Remove bleed water and laitance
 - iii. Hand trowel using pressure, or power trowel
 - iv. Steel trowel to produce a smooth finish, or wood float to produce a slip-free surface
 - v. Do not add water or neat cement
 - vi. Sand-cement screeds: minimum 30mm thick, 1:3 cement/sand mix, in accordance with SANS 10109-2:2004, Concrete floors. Part 2.

3.1.25.9 Surface Regularity

- a) Surface regularity: SANS 1055 Grade II.

3.1.25.10 Joints

- a) Construction joints:
 - i. Spacing and pattern: <4,5m in both directions;
 - ii. Saw joints with a mechanical concrete saw to blade width and a depth of one quarter of the slab thickness.

Contractor

Witness 1

Witness 2

Employer

Witness 1

Witness 2

- iii. Saw only after concrete has hardened sufficiently but before shrinkage cracking can occur (between 4 and 48 hours after placement depending on temperature).
- b) Construction or day joints:
 - i. Cast at end of day's casting or where concreting has stopped for more than 45 minutes.
 - ii. Type: keyed, keyed-and-tied, dowelled, or reinforced butt joints as directed, or as specified.
 - iii. Keyways: trapezoidal or rounded; coat joint face of keyways with suitable debonding agent like lime wash or bitumen.
 - iv. Dowels: 16mm diameter x 300mm length plain round mild steel dowels to SANS 920, placed at mid-depth of the slab at 300mm spacing; coat dowels for two-thirds of their length with a bond-breaking compound.
 - v. Round off all construction joints edges to a radius of 3mm.
- c) Isolation or movement joints:
 - i. Position: where floors abut fixed structures like walls, columns, sumps or inspection chambers, or in external floors or paving at spacing <4,5m in both directions.
 - ii. Forming: 20mm thick compressible material like polystyrene.
 - iii. Sealing: leave joints open or seal as specified; seal with suitable elastomeric material; ream sawn joints to width and depth as required and according to the sealant manufacturer's instructions.

4. Masonry

4.1 Masonry walling

Applicable standard: SANS 2001-Construction Works Part CM1: Masonry Walling

Specification data:

4.1.1 Burnt clay masonry units

- a) Burnt clay masonry units: SANS 227.
 - i. Class of common units: NFP for general masonry above damp-proof level to be plastered; NFX for masonry exposed to damp or in contact with the ground (e.g. foundation walls, manholes), or for fair face work;
 - ii. Nominal dimensions: 222 x 103 x 76 mm, or as specified;
 - iii. Nominal compressive strength: to Table 1 of SANS 2001 – Construction Works Part CM1;
 - iv. Uniformity of colour and texture of face units: provide sample of 20 units;
 - v. Grade of efflorescence: normal for internal walls not exposed to damp; special for visible unplastered foundation walls, retaining walls and free-standing walls;

Contractor

Witness 1

Witness 2

Employer

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Witness 2

- vi. Limits of water absorption: 6% - 16%;
- vii. Limits of moisture expansion: 0,20%; and
- viii. Required marking: designation on each dispatch or consignment note.

4.1.2 Concrete masonry units

- a) Concrete masonry units: SANS 1215
 - i. Nominal compressive strength: SANS 2001 – Construction Works Part CM1 Table 1;
 - ii. Average drying shrinkage: normal (0,06%); and
 - iii. Required marking: designation on each dispatch or consignment note.

4.1.3 Cement

- a) Common cements shall comply with the requirements of SANS 50197-1.
- b) Masonry cements shall comply with the requirements of SANS 50413-1.

4.1.4 Lime

- a) Lime for mortar shall comply with the requirements of SANS and shall be of class A2P.

4.1.5 Mortar

- a) Sand: to SANS 1090 when specified, free from organic matter, and tested with the requirements of SANS 10164-1.

4.1.6 Reinforcement

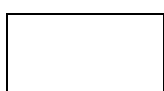
- a) Brick reinforcement in corrosive areas:
 - i. In coastal regions: galvanized to SANS 935 of 121, or stainless steel;
 - ii. In tidal splash zone: stainless steel; and
 - iii. Non-metallic ties (engineered polymer) may be used instead of stainless steel.
- b) Metal tie type: butterfly or modified to the Engineer's requirements.

4.1.7 Water

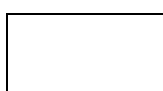
- a) The water used shall be fit for drinking.

4.1.8 Infill concrete

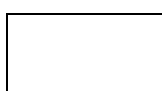
- a) Infill concrete shall comply with the requirements of SANS 2001-CC2 and shall have a maximum size of 13mm nominal aggregate and be of the following grades:
 - i. Unreinforced cavities, cores, pockets or spaces: Grade 10 or higher.
 - ii. Reinforced cavities, cores, pockets or spaces: Grade 25 or higher.



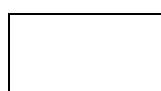
Contractor



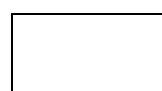
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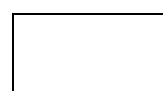
Witness 2



Employer



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4.1.9 Precast prestressed concrete lintels

- a) To comply with the requirements of SANS 1504.

4.1.10 Damp-proof course material

- a) Horizontal and vertical damp-proof course materials shall comply with one of the following standards:
 - i. SANS 248.
 - ii. SANS 298.
 - iii. SANS 952.

4.1.11 Work

- a) Single leaf bond: stretcher.
- b) Multi leaf bond: stretcher and brickforce, or as specified.
- c) Reference panel: required.
- d) Position of control and articulation joints: as specified.
- e) Degree of accuracy: II.

4.1.12 Additional requirements

- a) Wall ties in partial fill insulated cavity walls.
 - i. To have drip in centre of residual cavity.
 - ii. Tie spacing: SANS 10164 (2,5/m² or 600mm vertical, 660mm horizontal, staggered).
 - iii. Tie spacing around openings and construction joints: <300mm vertical.
- b) Tie mortar cover: 15mm minimum to outside face of mortar joint.
- c) Ancillary fabricated components for masonry, e.g. ties, brackets, lintels, shelves, anchors, meshwork: galvanized to SANS 121 in coastal regions.
- d) Clay facing units: obtain from manufacturer/ supplier agreement on the following in writing:
 - i. The required application e.g. type of building, finish etc.
 - ii. The degree of exposure to weather conditions, proximity to the sea etc.
 - iii. Track record of the preferred brick in the area of the building.
 - iv. An undertaking of warranty that the bricks delivered will be suitable.
 - v. Colour expectations in the case of face bricks.
 - vi. Acceptable levels of breakage during delivery to site.
- e) Common solid masonry mortar joints:
 - i. Rake out for receiving plaster.
 - ii. Flush off where walls are to be bagged or fair-faced.
- f) Hollow masonry mortar joints:

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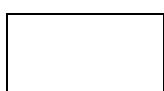
- i. Do not rake out receiving plaster.
- g) Protection against damage:
 - i. During construction, partially completed masonry, which is not enclosed or sheltered, shall be protected.
 - ii. Masonry shall be temporarily braced or otherwise stabilised, as necessary, to resist wind and other lateral forces during construction, in such a manner that the structural integrity of the masonry is not impaired.
 - iii. Completed masonry shall be suitably protected against surface contamination, construction damage, rain and rapid drying out for two (2) days, or until built upon or covered, whichever is the lesser period.
- h) Cleaning of finished work:
 - i. Completed masonry shall be free of stains, mortar, infill concrete droppings, debris, etc.
- i) Roof anchors:
 - ii. To be provided in accordance with the requirements of SANS 10400.

4.2 Steel door frames and windows

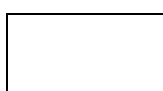
- a) Steel doors and windows frames shall comply with SANS 1129 and SANS 727, respectively.
- b) Near coastal areas the frames shall be hot-dip galvanized with a thickening of not less than 450g/m², as instructed by the Engineer.
- c) When built into masonry, frames shall be set in position, securely braced, and strutted before being built in.
- d) Articulation joints at doors shall be provided in accordance with the scope of work.

4.3 Masonry-type facings

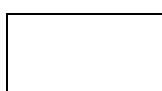
- a) Waterproofing: coat wall face with bituminous compound before covering with facings.
- b) Matching when relevant: lay out slabs of natural stone to match veining, colour and texture, number each slab and fix in same relative position.
- c) Attachment devices: 20 x 3 mm L-shaped stainless lugs shot-nailed to background at 1m intervals and staggered.
- d) Support shelf: 100 x 100 x 8 hot dip galvanized steel continuous angle bolted to structure with 30 x 6 flat steel hangers at 1,5m intervals.
- e) Grouting, fixing of cramps, engaging cramps in dovetailed metal channels secured to backing with through-bolts or cramps, adjustment in cramps, attachment of lintels and soffits, alignment.
- f) Of joints and facings: SANS 10073.
- g) Clean down, cover up to prevent soiling during progress of remaining work, remove covering



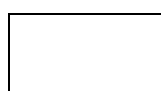
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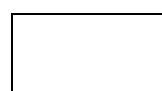
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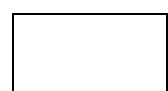
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upon completion and clean down again.

- h) Joints: 3mm wide between panels, sealed with suitable sealant of acceptable colour.

5. Structural Timberwork

5.1 Structural timberwork (Roofing)

Applicable standard: SANS 2001- Construction Works Part CT2: Structural Timberwork (roofing).

Specification data:

- a) Pole preservation treatment marking: metal identification tag with hazard class on each pole.
- b) Exposed faces of sawn timber: planed, sandpapered, and are rounded to 3mm radius.
- c) Discontinue timber members on both sides of fire walls.

5.2 Structural Timberwork

- a) **Nomenclature of timbers:** - Timber description as “softwood” is to be South African softwood of the relevant type, grade, etc. as specified. The names used for imported timbers are those given in Supplement No. 1 to SANS Code of Practice 12 under “Nomenclature of Standard Trade Names of Imported Commercial Timbers used in South Africa” and the Contractor is referred thereto.
- b) **Timber sizes:** - Sawn and wrot timbers are to be of the full sizes stated.
 - i. Where “Out of” sizes have been shown for wrot timbers on the drawings, an allowance of 4mm.
 - ii. For each wrot face off the sizes shown has been made.
 - iii. Doors, fanlight, sashes, manufactured boarding, plywood, veneers, etc. must be of the full thickness specified.
 - iv. Where doors, door frames, fanlights and frames, sashes, windows and frames are measured as numbered items, the overall sizes are given to the nearest 10mm.
 - v. Tolerances in nominal dimensions for imported timber shall not exceed the following:

For nominal dimensions up to 76mm the actual dimension may be 2.5mm under for each 25mm.

For nominal dimensions 76mm and over the actual dimension may be 1.6mm under for each 25mm.

- c) **Storage of timbers:** -
 - i. Timber delivered to the site is to be properly stacked above ground, either on bearers or platforms under cover and protected from inclement weather.
- d) **Orders:** -
 - i. For timber, are to be placed immediately after the Contract is signed, as the Contractor will be held responsible for any delay in delivery.
- e) **Pre-treatment of timbers:** -
 - i. All permanent timbers installed in the buildings are to be treated against borer,



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- cryptotermes, termites, and all wood destroying agencies with an
- ii. Approved preventative, all in accordance with SANS Code of Practice 05.
 - iii. Any surface subsequently exposed by cutting or planing must be touched up with the same preservative solution and rates are to include for all preservative required.
 - iv. The Contractor is to obtain a certificate from the merchants supplying the treated timber, to the effect that the timber has been treated against wood destroying agencies. The Engineer or Client Department has the right to remove samples of the treated timber to have tests carried out by the Division of Entomology or any other Authority.
 - v. Temporary timber on the site, e.g. shuttering props, etc. must be free from wood destroying agencies. Any timber so affected is to be immediately removed from the site.
 - vi. The moisture content of 10% of all timber brought to site shall be confirmed, in accordance with the relevant methods given in SANS 1783-1. (For all timber except poles, where SANS 457-2 or SANS 457-3).
 - vii. Materials which do not comply with the above requirements or are in any way damaged or discoloured by the pre-treatment must be replaced by the Contractor at his/her own expense.
- f) Stress grading of softwood timber: -
- i. The Mechanical Stress Grading of Softwood Timber (Flexural Method) shall be in accordance with SANS Code of Practice 0149.
- g) Structural timber: -
- i. For carpentry is to be South African softwood in accordance with SANS Specification 563 and, unless otherwise specified, of Stress Grade V4, and branded accordingly. If it is necessary to use sizes that have to be re-sawn, these shall be re-graded and stamped with the respective SANS stress grade mark. Unless this is done, timber which is re-sawn is no longer considered as complying with the specification and shall on no account be used.
 - ii. Nails shall comply with SANS 820.
 - iii. Nuts shall comply with the requirements of SANS 1700-14-1, SANS 1700-14-2, SANS 1700-14-3, and shall a shank that is 20mm longer than the total thickness of the timber which is to be bolted together.
 - iv. Bolts shall comply with the requirements of SANS 1700-14-1,
 - v. SANS 1700-14-2, SANS 1700-14-3, or SANS 1700-14-4.
 - vi. Nail plates shall be installed by means of a mechanical pressing device/carpenter's hammer.
 - vii. Nail plates, split rings, and shear plates shall comply with the requirements of SANS 10243.



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h) Brandering/battens: -

- i. Battens of cross-sectional size 50 x 50 mm and under shall be South African softwood (S.A. Pine), in accordance with SANS 1783-4 or SANS 1707-2, SANS 653 and branded accordingly.

i) Joinery and shelving: -

- i. Softwood for joinery and shelving shall be South African softwood (S.A. Pine) in accordance with SANS Specification 1359 and branded accordingly. All timber for joinery is to be air or kiln-dried to a moisture content of approximately 12%. Shelving to linen stores to be timber slatted with wall bands or free-standing units as specified.

5.3 Drawings

- a) The Engineer shall provide details of all roof assemblies, showing all members sizes required, connection details and bracing, where required.

5.4 Erection

- a) All framework shall be carried up true and plumb and temporary erection bracing shall be introduced wherever necessary to take care of all loads to which the structure may be normally subjected. Such bracing shall be left in place as long as may be required for safety.
- b) The Contractor is to provide and maintain temporary support to all framework until it is adequately built into the final structure.
- c) Upon completion all trusses shall be checked for straightness, plumpness, and that they are level, and shall be adjusted, as necessary, on the wall plate. The remainder of the permanent bracing shall be fixed.

5.5 Structural Laminates Timber

- a) Structural laminated timber: SANS 1460
- b) Required marking on each piece: application, exposure class, type, appearance and finish, stress grade, e.g. S2GP5.
- c) Timber sizes are to be of the sizes detailed, wrot on all faces and are to be manufactured by an experienced fabricator to the approval of the Engineer. Adhesives used must meet the requirements of the current SANS 1204 for external use.
- d) The surface appearance of members shall be Class C (Constructional) or Class S (Selected) as defined in SANS Specification 876 and as stated in the items.

6. Structural Steelwork

6.1 Structural steelwork

Applicable standard: SANS 2001-Construction Works Part CS1: Structural Steelwork

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Specification data:

6.1.1 Materials

- a) Unless otherwise shown on the drawings or hereunder, all rolled sections shall be hot rolled mild steel, and all materials shall comply with one of the following:
 - i. Weldable Structural Steels to SANS 4360;
 - ii. Hollow sections to SANS 4848 Part 2 and SANS 6323;
 - iii. Cold rolled sections to SANS 2994;
 - iv. Black bolts and nuts to SANS 135;
 - v. Precision bolts and nuts to SANS 136;
 - vi. High-strength friction-grip bolts and nuts to SANS 1282;
 - vii. Flat and tapered washers to SANS 1149; and
 - viii. Electrodes for welding to SANS 455.
- b) All structural steel material used shall be new and grade as specified on the Construction drawings, steel in accordance with SANS 50025 / EN 10025 unless stated otherwise on the drawings. "Commercial" quality plate which does not meet the above standard shall not be used without the Engineer's prior approval. The Contractor shall, if necessary, satisfy the Engineer from his/her records that all materials meet the above requirements.
- c) The work, including design, shall be carried out in accordance with SANS 10162. The steelwork shall be supplied complete with all necessary cleats, brackets, connections, trimmers, packing, shelf angles, etc. as specified on the drawings.

6.1.2 Fabrication Drawings

- a) The successful Tender shall prepare and submit a full set of fabrication to scale including the design of connections to the Engineer for approval and no fabrication shall be put;
- b) In hand until the necessary approval has been given.
- c) The Contractor shall be responsible for the consequences of discrepancies, errors or omissions in the shop details whether such drawings have been approved by the Engineer.
- d) The Contractor shall check the site dimensions and shall amend the drawings where necessary to suit the site dimensions. Any errors in fabrication resulting from incorrect dimensions will be the responsibility of the Contractor.
- e) The Contract shall allow a period of two (2) weeks for the approval of any drawings.

6.1.3 Fabrication and Assembly

- a) The Contractor shall prepare and submit a full set of fabrication drawings to scale including the design of connections to the Engineer for approval and no fabrication shall be put in hand

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until the necessary approval has been given.

- b) The Contractor may use welded or bolted construction in agreement with the Engineer, unless a particular method specified either in writing or on the drawings. All structural steel both before and after fabrication shall be, within the tolerances specified and shall be flat, straight (unless required to be formed to another shape) and free from twists.

6.1.4 Cutting

- a) Cutting of rolled steel joints and channel sections shall be by sawing. Cutting of angles, flats and plates shall be by sawing, shearing or cropping. Flame cutting will not be permitted.
- b) All edges shall be free from any defects of distortions and any notch or similar defect shall be removed by grinding.

6.1.5 Joints in Bearing

- a) The abutting surfaces of a joint dependent on contact for the transmission of load are, in the opinion of the Engineer, in contact. Splice plates and bolts for this type of connection should be so designed that they are capable of transmitting 100% of the design load.

6.1.6 Welding

- a) Care should be taken that distortions due to welding are prevented by clamping and pre-setting or other acceptable procedures.
- b) All welding shall be metal to metal arc welding with electrodes and operation suitable for the basic material in accordance with SANS 455. The Contractor shall, if required by the Engineer, produce evidence that each welder has satisfactorily completed tests appropriate to the work, and the Engineer is empowered to call for additional tests to be carried out under supervision.
- c) All butt welds in tension members shall receive special attention and the Engineer has the right to call 10% of such welds to be radiographically examined, with additional tests if the initial inspections prove unsatisfactory. The costs of these tests shall be included in the rates quoted. The welds shall be of Grade B Standards (SANS 10044 PT III).
- d) The fusion faces of welds shall have close contact and shall be cleaned free of scale, rust, oil or paint or any substance, which might impair the quality of the weld.
- e) All fetting shall be done by a method approved by the Engineer.

Tender Number: _____

Tender's Authorised Signatory: _____
Name in block letters Signature

Full Name of Tendering Company:

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LEPELLE NORTHERN WATER

CONTRACT NO.: GTAC 003-2023-23

**OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMES
UPGRADE: ELECTROMECHANICAL REFURBISHMENT OF
OLIFANTSPOORT PUMP STATIONS (PS1, PS2 & PS3)
AND EBENEZER WATER TREATMENT WORKS
AND PUMP STATION**

PORTION 2: CONTRACT

PART C4: SITE INFORMATION

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C4.1 ATMOSPHERIC AND CLIMATIC CONDITIONS

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
YEAR	494.9	73.3

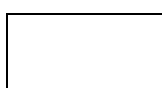
C4.2 ENVIRONMENTAL

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.

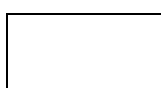
The Environmental Management Plan, which is to be strictly adhered to during all activities involved in the performance of this Contract, is included in Document 1 of 2 under Section C1.2 Annexure E.

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.

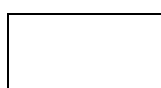
The Contractor will be responsible for environmental control on site during construction and the maintenance period. The construction activities will be monitored by an independent environmental specialist and audited against the EMP.



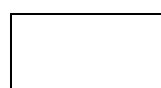
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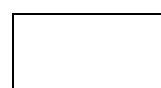
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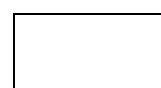
Witness 2



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C4.3 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, eg., 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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LEPELLE NORTHERN WATER

CONTRACT NO.: GTAC 003-2023-23

**OLIFANTSPOORT AND EBENEZER WATER SUPPLY SCHEMES
UPGRADE: ELECTROMECHANICAL REFURBISHMENT OF
OLIFANTSPOORT PUMP STATIONS (PS1, PS2 & PS3)
AND EBENEZER WATER TREATMENT WORKS
AND PUMP STATION
PORTION 2: CONTRACT**

PART C5: ANNEXURES

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PART C5: ANNEXURES

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C3.5.1 BASELINE RISK ASSESSMENT

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